AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 18, NO. 31. WEEKLY. | NEW YORK, THURSDAY, AUGUST 1, 1895. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

COPYRIGHT 1895, BY AMERICAN MACHINIST PUBLISHING COMPANY.

For Sale Everywhere by Newsdealers. ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

The Hornsby-Akroyd Oil Engine.

It may be known to some of our readers that the De La Vergne Refrigerating Machine Company, of this city, seeking other worlds to conquer, have lately been making arrangements to put upon the market, in such quantities as the trade developed may demand, an oil engine that already has established itself and come into extensive and rapidly widening use in England, Germany and elsewhere in Europe. As narrated in our columns, on May 2d of this year, in a report of a meeting of New York members of the American Society of Mechanical Engineers, when gas engines and oil engines were the topic of discussion, Mr. George Richmond, a member of the society and mechanical engineer of the De La Vergne Co., went to Europe a couple of years ago with the intention of studying the gas motors in such extensive use there to select a suitable motor for driving small refrigerating plants. Mr. Richmond spent several months in his investigations, and they finally took a rather unexpected direction. Mr. Richmond found that the oil engine was rapidly cutting into the field of the gas engine, and in numerous cases cutting it out. The oil engine that has been doing these wonders in Europe is the engine which the De La Vergne Co. are manufacturing, and which we take pleasure in presenting to our readers—the Hornsby-Akroyd oil engine.

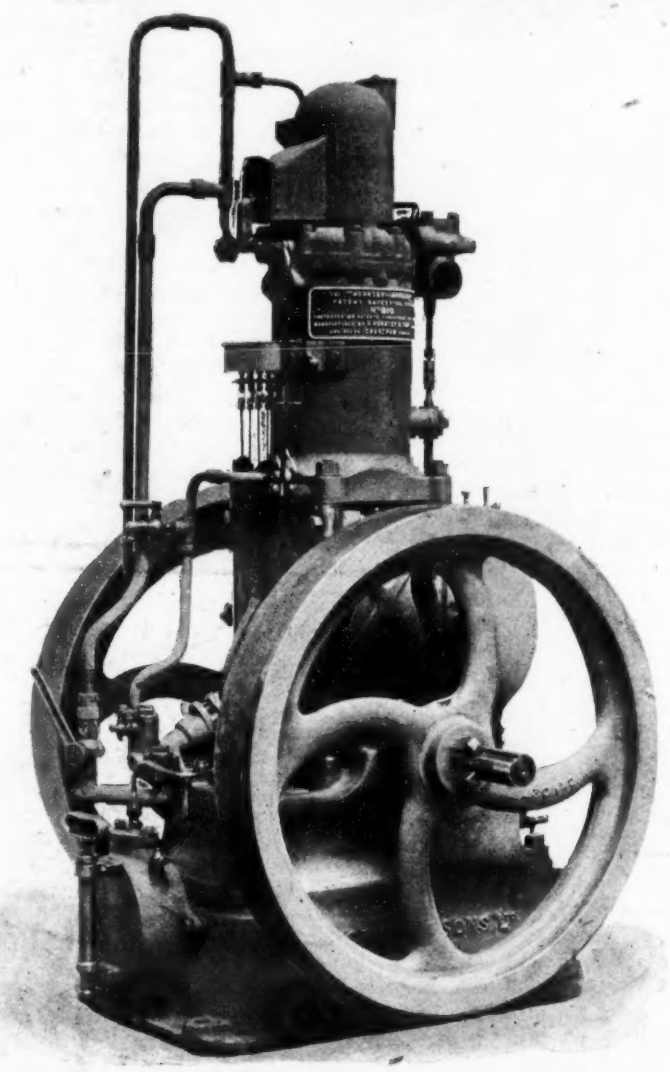
It seems proper, in the beginning, to understand what an oil engine is, as the term is often used in a very loose manner to describe a variety of engines in connection with which oil is used as a fuel. Some steam engines in which steam is generated by liquid fuel are called oil engines. Gas engines, for which the gas is prepared on the spot by carbureting air with naphtha or gasoline, are also improperly called gas engines. The term should properly be restricted to an engine using a heavy oil from which gas cannot be made without the application of heat, and it is in this sense that it is used here.

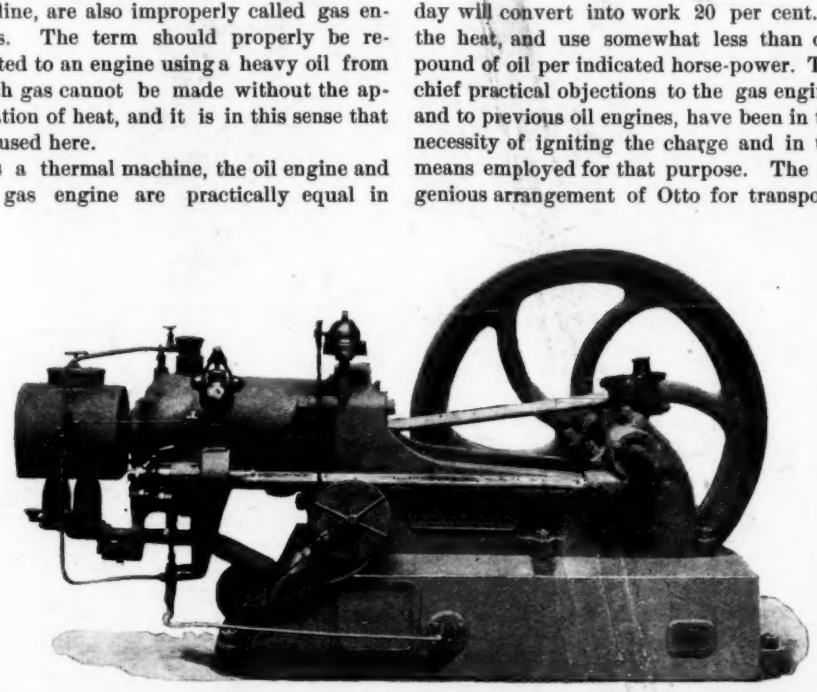
As a thermal machine, the oil engine and the gas engine are practically equal in economy, while both are in this respect much superior to the steam engine. Where illuminating gas is used it is much more costly than oil because the gas companies have first to realize their profits for generating the gas. The oil engine of the present day will convert into work 20 per cent. of the heat, and use somewhat less than one pound of oil per indicated horse-power. The chief practical objections to the gas engine, and to previous oil engines, have been in the necessity of igniting the charge and in the means employed for that purpose. The ingenious arrangement of Otto for transporting a flame into the body of the cylinder was regarded in its day as a triumph of mechanical skill, but the dry heat caused a rapid deterioration of the valve.

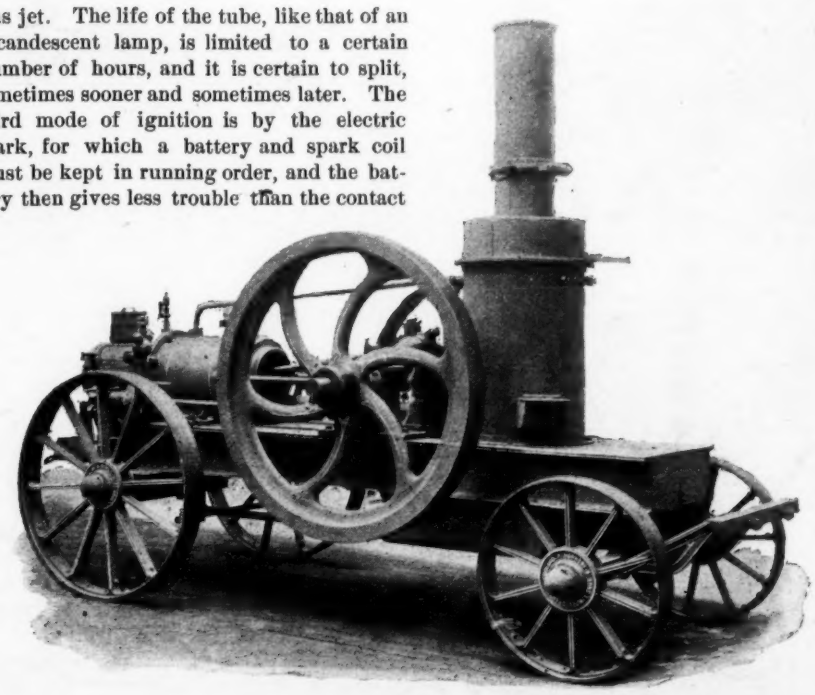
"Tube" ignition followed, where the tube is maintained at a red heat by a constant gas jet. The life of the tube, like that of an incandescent lamp, is limited to a certain number of hours, and it is certain to split, sometimes sooner and sometimes later. The third mode of ignition is by the electric spark, for which a battery and spark coil must be kept in running order, and the battery then gives less trouble than the contact points themselves within the cylinder, which are liable to become covered with incrustation. The numerous patents covering devices which propose to improve the systems of tube and electric ignition show that the difficulties to be overcome are not imaginary, and every user of a gas engine knows that they are not. Beau de Rochas, who described even if he did not use the four cycle system now known under the name of Otto, recommends that the compression should be carried to a point at which the explosion would be automatic. In the Hornsby-Akroyd engine we have the first example of a perfectly successful carrying out of this idea.

The automatic explosion is not in itself a difficult thing to accomplish, but it has been heretofore difficult to secure this automatic explosion at the proper moment. A valve motion for timing the explosion would suggest itself, but when it is considered that such a valve would be subjected to a temperature considerably above red heat that device is evidently impracticable. We may now look at the manner in which this explosion is obtained in the Hornsby-Akroyd oil engine.

To those who are entirely unfamiliar with this type of engine it should be explained that the cylinder is closed at one end and open at the other, with a "trunk" piston, the connecting rod being attached within the piston and the other end of it, of course, turning the crank. The cylinder is water-jacketed to keep the temperature down to a practical limit. The force which is transmitted to the crank shaft, or the entire power developed by the engine, is applied behind the piston at every other outward stroke, or at one-half of each alternate revolution of the crank shaft. The complete cycle of the operation of the engine is comprised in two whole revolutions of the crank shaft, or four strokes of the piston as follows: First, the outward or forward stroke of the piston, when the cylinder is filled with pure air admitted from the atmosphere, and a charge of oil is injected into the vaporizing retort sufficient for one stroke of the engine. Second, the return stroke of the piston, when the air is compressed in the cylinder and mixes more or less intimately with the vaporized







THE HORNSBY-AKROYD OIL ENGINE.

oil, forming an explosive mixture. At the end of this piston stroke, or at the beginning of the next, the explosion occurs. In the third half stroke, or the second forward stroke of the piston, it is driven forward by the expansion of the exploded gases. On the second return stroke of the piston the used-up gases are expelled from the cylinder and the cycle of operations is then repeated, and so on continuously. Referring now to Figs. 1, 2 and 3 we may look into the operation a little more closely. In these figures conventional marks are used indicating respectively pure air, oil and ignited gases. The crosses indicate pure air, the circles oil, and the squares the burnt gases. The closed end of the cylinder, it will be seen, is provided with an extension communicating with the cylinder by a relatively narrow neck. While the cylinder is water-jacketed this extension is not, as it must remain hot and forms the retort in which the oil is vaporized. Nothing but oil in the liquid form is injected into the retort, and only air is drawn into the cylinder.

On the completion of the first outward stroke of the piston, the air having been drawn into the cylinder and the oil having been injected into the retort, the conditions are as represented in Fig. 1. We have in the retort oil vapor, which alone is not explosive, and in the cylinder we have pure air, which also alone is not explosive, and there is not sufficient leakage or passage from one to the other to render either explosive. On the return stroke of the piston the air being compressed is forced from the cylinder through the communicating neck into the retort, and the conditions are then as represented in Fig. 2. For a time during the progress of this stroke the oil vapor continues too rich for explosion, but as the piston advances sufficient air is forced in and mixed with the oil vapor to render the mixture explosive. While Fig. 2 shows the mixing process, Fig. 3 by its conventional marking indicates that the ignition or explosion has taken place, and the cylinder and retort are then filled with burned gases. This automatic explosion in this engine is found to take place exactly as the piston is beginning its return stroke, as shown in the indicator diagram, Fig. 4.

The practical result of the ignition or explosion is that a great increase in pressure occurs in the retort and cylinder, and this pressure operates to drive the piston outward or forward and give added impulse to the crank shaft. Many have supposed that the explosions which occur in gas engines or in genuine oil engines act upon the piston like the blow of a sledge, and that the force of this blow is the motive force of the engine. This is evidently not so as the indicator diagram shows that the driving force is in the expansion of the high-pressure gases during the entire ensuing forward stroke of the piston. The increase of pressure caused by the explosion is due almost entirely to the great increase of temperature resulting from the instantaneous combustion of the vaporized oil. At the beginning of the driving stroke the temperature is very high, falling, as with all expanding gases, during the stroke, but still making the water jacket a necessary feature. It will be noticed that the ignition takes place within the retort, the piston being protected by a layer of pure air. It is not claimed that these diagrams are exact representations of what actually takes place within the cylinder, but their substantial correctness seems to be indicated by the fact that the piston rings do not become clogged with tarry substance as is usually the case with this class of engines. The surplus air should insure complete combustion, and that it is accomplished is shown from official analyses that have been made of the escaping gases. These analyses indicate that the oil is completely burned in the engine with excess of oxygen. The products of combustion consist mainly of steam and carbonic acid diluted with nitrogen and oxygen, no traces of carbonic oxide being detected, so that the exhaust is not in any way objectionable.

The engine is governed by controlling the supply of oil that is fed to the engine. The oil is sent to the retort by a small pump which continually supplies enough for the full power that the engine is expected to develop. If less power is being used a high-speed Porter governor operates a by pass and allows the surplus oil to flow back to the oil reservoir in the base plate of the engine.

A representative of the American Machinist called recently at the De La Vergne

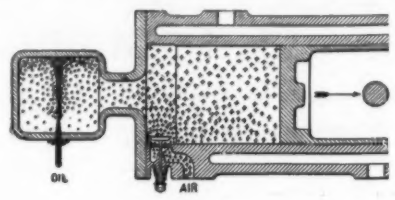


Fig. 1.

Refrigerating Machine Company's works and saw one of these engines in operation in the pattern shop and driving the tools of the shop. The engine is 7 inches by 10 inches, and is similar in appearance to the horizontal engine shown in the half-tone cut given herewith. We found it quite interesting to

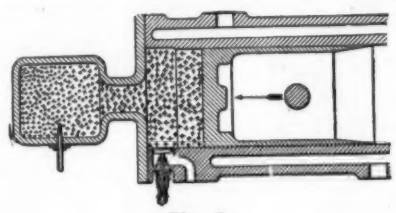


Fig. 2.

watch the promptness with which the overflow of oil changed as the several machines were thrown on and off, and the uniformity of speed maintained. The engine has been running in this place for nine months, and the conditions are as trying as could well have been selected. The power required will vary from the full capacity of the en-

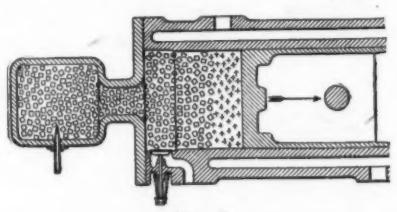


Fig. 3

gine to nearly nothing half a dozen times in ten minutes. When running light nearly all the oil is seen to run back, and the moment the circular saw is thrown on the overflow of oil ceases, and the engine without any laboring takes hold of the work. Standing beside this engine we see before us everything involved in the power plant. There is no boiler or gas generating plant or other source of supply out of sight. The engine runs without attention, provision being made for the thorough lubrication of the several working parts. About ten minutes are usually required for heating the retort when the engine is first started, the means for this being provided as a part of the engine.

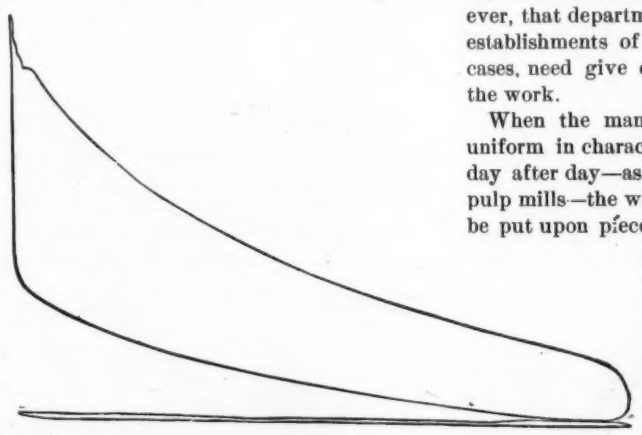


Fig. 4.

The De La Vergne Refrigerating Machine Company have created a special oil engine department under the management of Mr. George Richmond, and they expect to have ready for the market at an early date some twenty different sizes and styles of these engines, ranging up to forty horse-power. Each size and type of engine has been thoroughly tested and approved by the original builders before being put on the market, so that there is nothing of an experimental character involved in their production here. The half tones which we give of a horizontal, a vertical and a portable engine, respectively, are from photos taken in England.

Richard Hornsby & Sons, Limited, of Grantham, England, the original builders of this engine, and who thoroughly test every engine before it leaves their works, claim the unusual record of never having had an engine returned on their hands. The same conservative policy is intended by the De La Vergne Company.

A Piece-Rate System—II.*

By Fred. W. Taylor, Germantown, Philadelphia, Pa.

A great advantage of the differential rate system is that it quickly drives away all inferior workmen, and attracts the men best suited to the class of work to which it is applied; since none but really good men can work fast enough and accurately enough to earn the high rate; and the low rate should be made so small as to be unattractive even to an inferior man.

If for no other reason than that it secures to an establishment a quick and active set of workmen, the differential rate is a valuable aid, since men are largely creatures of habit; and if the pieceworkers of a place are forced to move quickly and work hard the day-workers soon get into the same way, and the whole shop takes on a more rapid pace.

The greatest advantage, however, of the differential rate piecework, in connection with a proper rate-fixing department, is, that together they produce the proper mental attitude on the part of the men and the management toward each other. In place of the indolence and indifference which characterize the workmen of many day-work establishments, and to a considerable extent also their employers; and in place of the constant watchfulness, suspicion, and even antagonism with which too frequently the men and the management regard each other, under the ordinary piecework plan, both sides soon appreciate the fact that with the differential rate it is their common interest to co-operate to the fullest extent, and to devote every energy to turning out daily the largest possible output. This common interest quickly replaces antagonism, and establishes a most friendly feeling.

The term "rate-fixing department" has rather a formidable sound. In fact, however, that department should consist in most establishments of one man, who, in many cases, need give only a part of his time to the work.

When the manufacturing operations are uniform in character, and repeat themselves day after day—as, for instance, in paper or pulp mills—the whole work of the place can be put upon piecework in a comparatively short time; and when once proper rates are fixed, the rate-fixing department can be dispensed with, at any rate until some new line of manufacture is taken up.

The system of differential rates was first applied by the writer to a part of the work in the machine shop of the Midvale Steel Company, in 1884. Its effect in increasing and then maintaining the output of each machine to which it was applied was almost immediate, and so remarkable that it soon came into high favor, with both the men and the management. It was gradually applied to a great part of the work of the establishment, with the result, in combination with the rate-fixing department, of doubling and in many cases trebling the output, and at the same time increasing instead of diminishing the accuracy of the work.

In cases where large and expensive machines are used, such as paper machines, steam hammers, or rolling-mills, in which a large output is dependent upon the severe manual labor as well as the skill of the workmen (while the chief cost of production lies in the expense of running the machines rather than in the wages paid), it has been found of great advantage to establish two or three differential rates, offering a higher and higher price per piece or per ton as the maximum possible output is approached.

The careful study of the capabilities of the machines, and the analyses of the speeds at which they must run, before differential rates can be fixed, which will insure their maximum output, almost invariably result in first indicating and then correcting the defects in their design, and in the method of running and caring for them.

In the case of the Midvale Steel Company, to which I have already referred, the machine shop was equipped with standard tools furnished by the best makers, and the study of these machines, such as lathes, planers, boring mills, etc., which was made in fixing rates, developed the fact that they were none of them designed and speeded so as to cut steel to the best advantage. As a result, this company has demanded alterations from the standard in almost every machine which they have bought during the past eight years. They have themselves been obliged to superintend the design of many special tools which would not have been thought of had it not been for elementary rate-fixing.

But what is, perhaps, of more importance still, the rate-fixing department has shown the necessity of carefully systematizing all of the small details in the running of each shop, such as the care of belting, the proper shape for cutting tools, and the dressing, grinding, and issuing same, oiling machines, issuing orders for work, obtaining accurate labor and material returns, and a host of other minor methods and processes. These details, which are usually regarded as of comparatively small importance, and many of which are left to the individual judgment of the foreman and workmen, are shown by the rate-fixing department to be of paramount importance in obtaining the maximum output, and to require the most careful and systematic study and attention in order to insure uniformity and a fair and equal chance for each workman. Without this preliminary study and systematizing of details, it is impossible to apply successfully the differential rate in most establishments.

As an illustration of the difference between what ought to be done by a workman well suited to his job, and what is generally done, I will mention a single class of work, performed in almost every establishment in the country. In shovelling coal from a car over the side on to a pile, one man should unload forty tons per day, and keep it up, year in and year out, and thrive under it.

With this knowledge of the possibilities, I have never failed to find men who were glad to work at this speed for from four and a half to five cents per ton. The average speed for unloading coal in most places, however, is nearer fifteen than forty tons per day. In securing the above rate of speed, it must be clearly understood that the problem is not how to force men to work harder or longer hours than their health will permanently allow, but rather, first, to select among the laborers which are to be found in every community the men who are physically able to work permanently at that job, and at the speed mentioned, without damage to their health, and who are mentally sufficiently inert to be satisfied with the monotony of the work, and then to offer them such inducements as will make them happy and contented in doing so.

The first case in which a differential rate was applied furnishes a good illustration of what can be accomplished by it.

A standard steel forging, many thousands of which are used each year, had for several years been turned at the rate of from four to five per day under the ordinary system of piecework, 50 cents per piece being the price paid for the work. After analyzing the job and determining the shortest time required to do each of the elementary operations of which it was composed, and then

* Abstracted from a paper presented at the Detroit Meeting of the American Society of Mechanical Engineers.

summing up the total, the writer became convinced that it was possible to turn ten pieces a day. To finish the forgings at this rate, however, the machinists were obliged to work at their maximum pace from morning to night, and the lathes were run as fast as the tools would allow, and under a heavy feed.

It will be appreciated that this was a big day's work, both for men and machines, when it is understood that it involved removing, with a single 16-inch lathe, having two saddles, an average of more than 800 pounds of steel chips in ten hours. In place of the 50-cent rate that they had been paid before, they were given 35 cents per piece when they turned them at the speed of 10 per day, and when they produced less than 10, they received only 25 cents per piece.

It took considerable trouble to induce the men to turn at this high speed, since they did not at first fully appreciate that it was the intention of the firm to allow them to earn permanently at the rate of $3.50 per day. But from the day they first turned 10 pieces to the present time, a period of more than ten years, the men who understood their work have scarcely failed a single day to turn at this rate. Throughout that time, until the beginning of the recent fall in the scale of wages throughout the country, the rate was not cut.

During this whole period the competitors of the company never succeeded in averaging over half of this production per lathe, although they knew and even saw what was being done at Midvale. They, however, did not allow their men to earn over from $2 to $2.50 per day, and so never even approached the maximum output.

The following table will show the economy of paying high wages under the differential rate in doing the above job :

COST OF PRODUCTION PER LATHE PER DAY.

Ordinary System of Piecework.		Differential Rate System.	
Man's wages.....	$2 50	Man's wages.....	$3 50
Machine cost.....	3 37	Machine cost.....	3 37
Total cost per day.	$5 87	Total cost per day.	$6 87
5 pieces produced.		10 pieces produced.	
Cost per piece.....	$1 17	Cost per piece.....	$0 69

The above result was mostly, though not entirely, due to the differential rate. The superior system of managing all of the small details of the shop counted for considerable.

There has never been a strike by men working under differential rates, although these rates have been applied at the Midvale Steel Works for the past ten years; and the steel business has proved during this period the most fruitful field for labor organizations and strikes. And this notwithstanding the Midvale Company has never prevented its men from joining any labor organization. All of the best men in the company saw clearly that the success of a labor organization meant the lowering of their wages, in order that the inferior men might earn more, and, of course, could not be persuaded to join.

I attribute a great part of this success in avoiding strikes to the high wages which the best men were able to earn with the differential rates, and to the pleasant feeling fostered by this system; but this is by no means the whole cause. It has for years been the policy of that company to stimulate the personal ambition of every man in their employ, by promoting them either in wages or position whenever they deserved it, and the opportunity came.

No system of management, however good, should be applied in a wooden way. The proper personal relations should always be maintained between the employers and men, and even the prejudices of the workmen should be considered in dealing with them.

The employer who goes through his works with kid gloves on, and is never known to dirty his hands or clothes, and who either talks to his men in a condescending or patronizing way, or else not at all, has no chance whatever of ascertaining their real thoughts or feelings.

Above all, it is desirable that men should be talked to on their own level by those who are over them. Each man should be encouraged to discuss any trouble which he may have, either in the works or outside, with those over him. Men would far rather even be blamed by their bosses, especially if the "tearing out" has a touch of human nature and feeling in it, than to be passed by day after day without a word, and with no more notice than if they were part of the machinery.

The opportunity which each man should have of airing his mind freely, and having it out with his employers, is a safety valve, and if the superintendents are reasonable men, and listen to, and treat with respect what their men have to say, there is absolutely no reason for labor unions and strikes.

It is not the large charities (however generous they may be) that are needed or appreciated by workmen, such as the founding of libraries and starting workingmen's clubs, so much as small acts of personal kindness and sympathy, which establish a bond of friendly feeling between them and their employers.

The moral effect of the writer's system on the men is marked. The feeling that substantial justice is being done them renders them on the whole much more manly, straightforward, and truthful. They work more cheerfully, and are more obliging to one another and their employers. They are not soured, as under the old system, by brooding over the injustice done them, and their spare minutes are not spent to the same extent in criticising their employers.

Even if all of the manufacturers in the country, who are competing in the same line of business, were to adopt these methods, they could still well afford to pay the high rate of wages demanded by the differential rate, and necessary to induce men to work fast, since it is a well-recognized fact the world over that the highest-priced labor, providing it is proportionately productive, is the cheapest; and the low cost at which they could produce their goods would enable them to sell in foreign markets and still pay high wages.

When employers herd their men together in classes, pay all of each class the same wages, and offer none of them any inducements to work harder or do better than the average, the only remedy for the men lies in combination; and frequently the only possible answer to encroachments on the part of their employers is a strike.

The level of the great mass of the world's labor has been, and must continue to be, regulated by causes so many and so complex as to be at best but dimly recognized.

The utmost effect of any system, whether of management, social combination, or legislation, can be but to raise a small ripple or wave of prosperity above the surrounding level, and the greatest hope of the writer is that, here and there, a few workmen, with their employers, may be helped, through this system, toward the crest of the wave.

Time Required to Stop Trains by the Air Brake.

We lately received from a correspondent an inquiry reading as follows :

Having been away for a number of months I have lost track of many of your articles in the MACHINIST. I wish to ask a question: Can you tell me whether the Westinghouse Air Brake Co. ever published an article in any paper, or put on record at the World's Fair a certain number of coaches on a train running a certain number of miles per hour, and stopping in a certain number of feet? If so, will you send me the same, and oblige a reader of the MACHINIST? I hope you will pardon me for asking further question No. 2: A passenger train with 7 coaches on, and running 40 miles per hour on level but sharp curve; how many feet ought they to run before coming to a stop?

By the kindness of Mr. R. A. Parke, Eastern Representative of the Westinghouse Air Brake Company, we are enabled to publish the following :

The inquiry which is made by your correspondent is an entirely natural one, and it would seem as though it were a simple matter to indicate the stop that should be made by a train of cars under varying conditions, and also to give some simple rule by which the length of stop may be computed. As a matter of fact, however, the question as to the distance in which a train can be stopped from a given speed, is very similar to the question "what is the size of a piece of chalk?" We will reply to your inquiries the best that we can with the information we have.

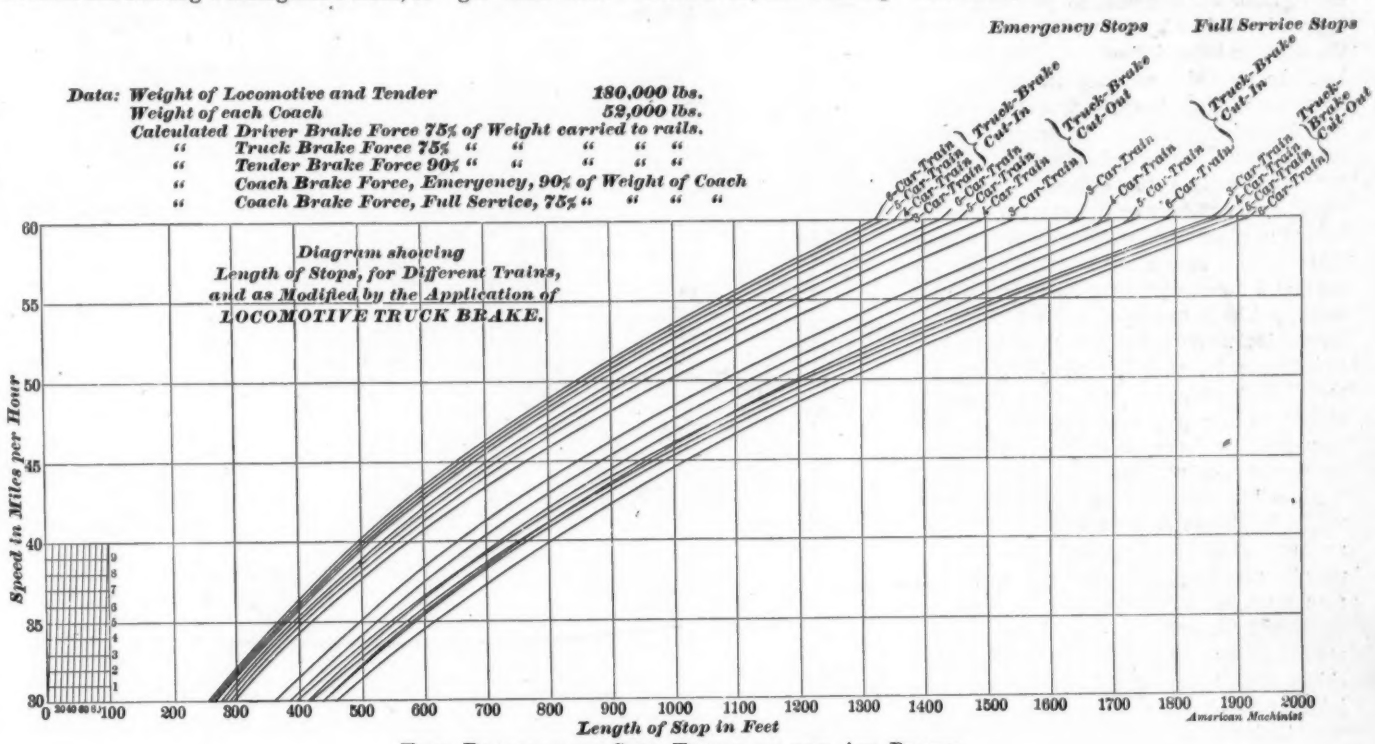
We have shown, on page 63 of our "Instruction Book," the results of a number of tests with a 50-car freight train in 1887. These are practically all the tabulated stops that we have published. These stops, however, are not a criterion for the stops of passenger trains at the present day.

There are a large number of conditions which affect the distance in which a particular train may be brought to rest from a given speed. In the first place, the material of which the brake shoes are constructed is a most important factor. Other things being equal, shoes of soft cast-iron, hard cast-iron, malleable iron, steel and composite shoes, will each produce a stop of different length from the same speed. In the next place, the character of the brake beam release springs, and the arrangement of the rods and levers, intermediate between the brake beams and the brake cylinder, have each an important influence. The actual ratio of the pressure of the brake shoes upon the wheels to the weight of the car is a very important consideration. This is not uniform upon the different cars of many roads. The question whether brakes are applied to the driving wheels of the locomotive is a most important one, and the ratio of the pressure of the driver brake shoes to the weight of the locomotive, and the ratio of the weight of the locomotive to the weight of the train, are important elements.

To tell, therefore, what should be expected for a train stop under particular conditions, implies the knowledge of a large number of detail matters concerning the particular train. Having this data, we are enabled to compute fairly closely the length of stop upon a level, or upon a uniform, known grade, providing the track is a tangent. We have no information upon which to base a computation for the length of stop upon a curve.

We have computed the lengths of stop for trains of different length and known conditions, one of which is that the driving wheels of the locomotive have brakes. We have also computed the stops for the same trains when the front truck of the locomotive is also equipped with a suitable brake. The results of these computations have been plotted, and we inclose herewith a print showing a diagram of the same. Those stops with the "truck brake cut in," are those in which the front truck of the locomotive is supplied with a brake. Those with "truck brake cut out," are where the driver brake of the locomotive is in use, together with the brakes upon the cars, but no brake upon the front truck of the locomotive. The conditions as to the weight of the different vehicles, and the percentage of that weight, which is calculated for the total brake shoe pressure upon the wheels of that vehicle, are shown. These results are for 3, 4, 5, and 6-car trains. The writer has, in addition, computed the length of stop of a train made up of the same locomotive and tender, with driver brakes, but no front truck brake upon the engine, and with seven coaches, each weighing 52,000 pounds, the stop being made upon a level tangent, from a speed of 40 miles an hour. The computed stop is 538 feet. All the stops shown upon the diagram are for level tangent track.

We regret that we cannot give you the exact information which you require. There is no simple formula for computing the length of stops, nor is there any reliable one which anyone but a brake expert could possibly use. It would therefore be of no interest to you to have it.


Emergency Stops
Full Service Stops
Data: Weight of Locomotive and Tender 180,000 lbs.
Weight of each Coach 52,000 lbs.
Calculated Driver Brake Force 75% of Weight carried to rails.
" Truck Brake Force 75% " " " " "
" Tender Brake Force 90% " " " " "
" Coach Brake Force, Emergency, 90% of Weight of Coach
" Coach Brake Force, Full Service, 75% " " " "
Diagram showing
Length of Stops, for Different Trains,
and as Modified by the Application of
LOCOMOTIVE TRUCK BRAKE.
Truck-Brake Cut-In
Truck-Brake Cut-Out
3-Car-Train
4-Car-Train
5-Car-Train
6-Car-Train
Speed in Miles per Hour
Length of Stop in Feet
American Machinist

TIME REQUIRED TO STOP TRAINS BY THE AIR BRAKE.

It is a rather curious fact that the vertical railway which has made the tall office building such a success, is also the one thing that will prevent them from going continually higher and higher. The higher the building the more elevators are required, and theoretically there might be a point where the building would be all elevators. Even with one-quarter of the space given to elevators the building probably would not pay.

Economy in Pattern Work.

By I. Whitehead.

Pattern work consists in mental and physical effort put forth to help the molder produce a casting of a definite form. In this work the patternmaker realizes more effort and less credit than the molder. He stands in the way between the employer and the casting, and is told that he is simply an expense.

How to reduce this expense is only to be solved by a review of the work and a study of how far the ordinary economic methods of manufacture will apply, and by which method the greatest advantage can be gained.

The advantage of division and subdivision of labor when applied to patternmaking is greatly limited by the varied character of the work and the limited extent of the market. In an independent pattern shop, we have negotiating, keeping accounts, collecting, designing, constructing, turning, circular and band sawing, jointing and varnishing, etc., besides the different classes of work, such as heavy or light, cored or solid, carved or plain. To perform all the parts of this work, a man must be of the highest skill, and able to perform the most difficult work, yet he is employed at least one-quarter of his time on inferior work which a boy could soon be made to perform equally well. Now, suppose that more work enabled him to employ a man and a boy. The man need not be equal to his employer, as he would still perform the most difficult work, while the man as a rougher hand would be able to do more work of his class, and, say, at 10 per cent. less, while the boy may be made equal to half the work of a man upon the easier parts of the work, at one-fourth the cost. If 30 or 40 men are employed in one shop, you can employ machines almost constantly, sawing, planing, jointing, turning, and other operations that would arise in the subdivision of work, together with training and educating more perfectly each in a special line, such as gears, cylinders, heavy or light work, etc., and thus the work is lifted above the competition of any except those who employ the same means. The work also is studied more in detail and admits of more system and uniformity, and is therefore of better quality.

The next feature of economy is in construction. This depends upon the judgment of the patternmaker as to the capacity of the molder and his appliances, together with a consideration of the nature of the material to be used so as to preserve its shape and size. Some molds can be made cheaper without pattern, by the use of sweeps, others with a combination of sweeps and parts of pattern, others with cores, while others require a complete pattern of the size and shape of casting required, except the allowance for shrinkage of metal. Thus a pattern may be made to cost more in the patternmaking and less in the molding, or more in the molding and less in the pattern, according to which workman is able to do the work cheapest.

Many of our largest and costliest patterns are being dispensed with by the molders' art, while in small patterns, when we require a great number of castings, we have the patternmaker help the molder by making a superior finish, forming his gates, parting, and by the use of follow boards, etc. For instance, if 16 castings are required from one pattern, and one hour's more work on the pattern would save the molder five minutes on each mold, there would be an economy of 20 minutes saved by the extra hour pattern work, while if there was but one casting to be made and the one hour extra pattern work was still spent upon it, there would be a loss of 55 minutes.

The tendency of patternmaking and molding as they progress in art, is that more of the large work is done by the molder, while more of the small work is done by the patternmaker in superior finish.

The next important object in construction is to obtain the necessary strength and preserve the shape. Soft yellow pine, well seasoned, is the best adapted for general use. Wood of any kind, however dry, is subject to change its size and shape in the hot or damp sand.

I have seen some well-finished patterns that were worthless through bad judgment in this respect. The best and cheapest way to overcome this difficulty is by framing and so using the lengthway of the grain in construction between the essential sizes, and also by leaving open joints in all plates, and so allow for the wood to swell and shrink independent of the outline of the pattern. Many other considerations are required for each pattern construction, such as the best way to mold it, and make the parting, taper, prints and core boxes, and loose pieces accordingly.

He must allow for shrinkage and finish of casting. Where there is a large range of work the shrink rule is often discarded, and the judgment and experience of the patternmaker substituted. When heavy and light parts occur in one casting, it will cause unequal shrinkage, which will crack the casting or draw it out of shape, thus weakening it through the unequal strains existing within itself.

From the nature of shrinkage in metals much strength can be gained for the same area by the rounding of all inside and outside corners, as the iron in cooling will contract or draw the crystals of iron from the hotter center to the cooling surface, while the center contracting after the outside is set, will cause the iron to become broken and spongy in the center. The rounding of corners inside and out as much as possible is necessary to counteract unequal strains, as well as an equal distribution of thickness of metal. It will be seen from these conditions that the designer, patternmaker, and molder are inseparable partners in the production of good and correct castings. It is also evident that size or weight is not strength, nor the lowest first cost, economy, but that the amount of intelligence and experience put into the work becomes the greatest factor.

The next consideration is the finished parts of a casting. These should be made to cast down, or in such position in the mold that it will receive the cleanest and soundest metal as far as possible.

To insure the special treatment which is necessary to the different parts of the mold, I advocate varnishing with different colors; for example, the parts that are to be finished or polished in the casting, to use clear varnish; for core prints, red, and for unfinished metal, black. By this means the molder can see at a glance the parts which require to be clean, and so without facing in the mold, while the black is finished, and the prints show the best place to vent, etc. The same in the core box, thus giving a chance to the molder to work more intelligently.

Now let us consider the tools used in the order of their importance. 1st. We require a firm bench with a true surface on top, with a good vise attached. This tool being in constant use, any disadvantage is constantly repeating itself, and if it is unduly neglected, becomes a source of great loss unconsciously. The next point is the tools which the workman generally supplies. If poorly furnished the loss largely falls upon the employer in wasted time and poorer work. It is the great number of small wastes that becomes the greatest loss, and to overcome this tendency somewhat, the employer might arrange as an offset to the machinist whose tools are furnished, a sum, say, of 25 cents per week as tool money, so arranged that it would be spent in keeping the supply up to the proper standard. Other tools in their order would be a lathe, circular saw, jig or band saw, jointer, etc., according to the size of shop, or the amount of work would warrant.

Finally, we may sum up the factors of economy in pattern work to be

1st. In division of labor through centralizing the work.

2d. Special tools.

3d. Intelligence of labor.

The checks to a division of labor are the limited market, and the great variety of the work.

There are two difficulties to enlarging this market. 1st. Much of the work requires a close co-operation with the foundry and drawing office, as shown, that one department can leave more or less work to the other as the case required.

2d. The altering of patterns kept at the works makes it very questionable whether the advantage of centralization of pattern work for different shops will outweigh the moving of the pattern from one shop to the other, etc.

The economy of tools, I need but mention, for improved machines are a great advantage to pattern work, though much limited by the nature of the work, as shown.

The third and last factor to consider is the intelligence of labor in pattern work. This feature is of the greatest importance, for the reason that the division of labor and special tools largely fail to simplify the work, leaving to it a larger range for judgment and skill, and so causing a greater

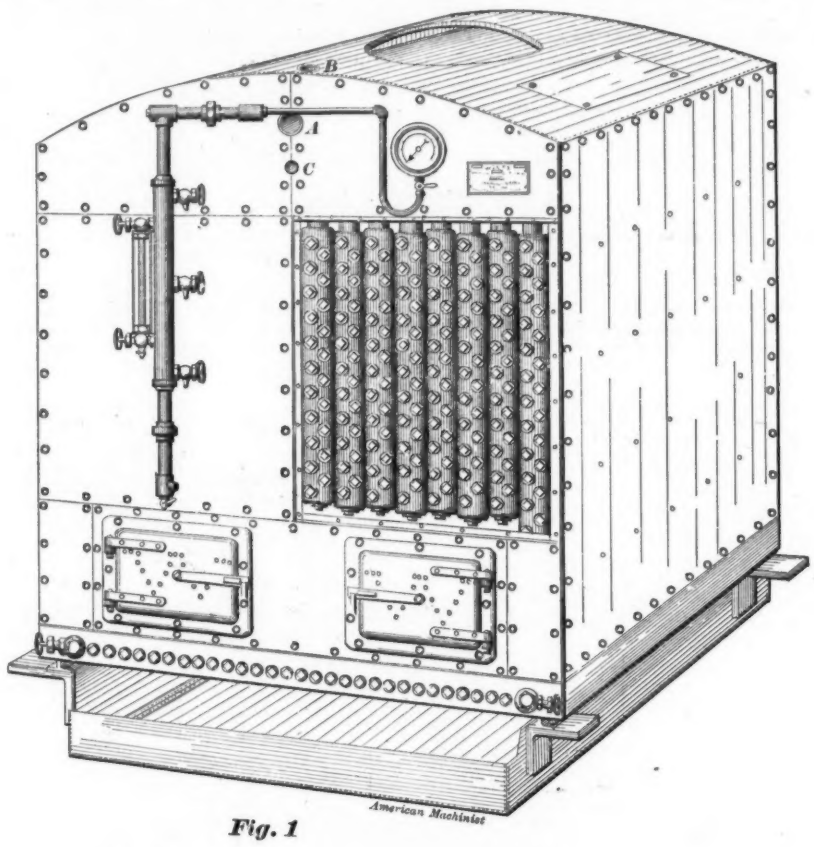


Fig. 1

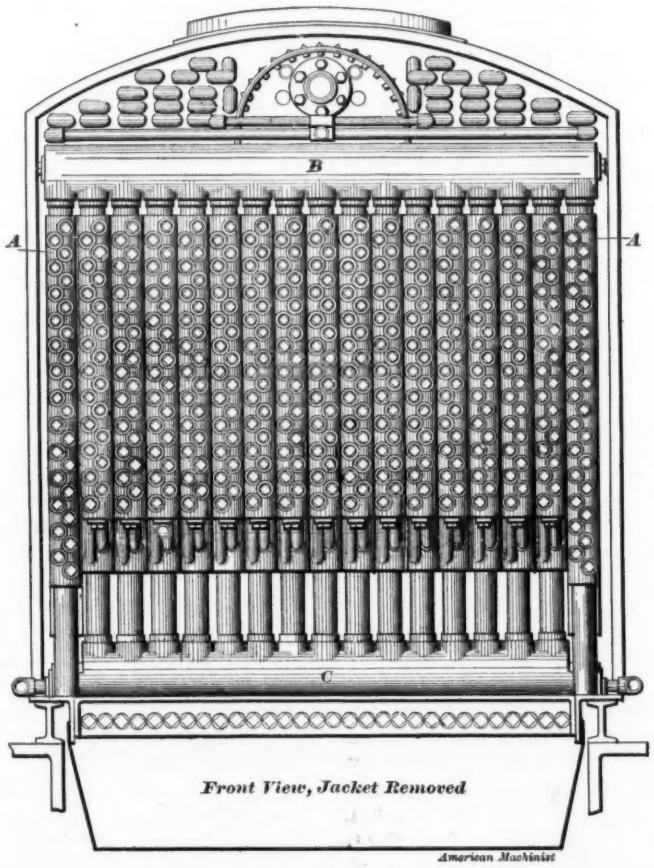


Fig. 2.

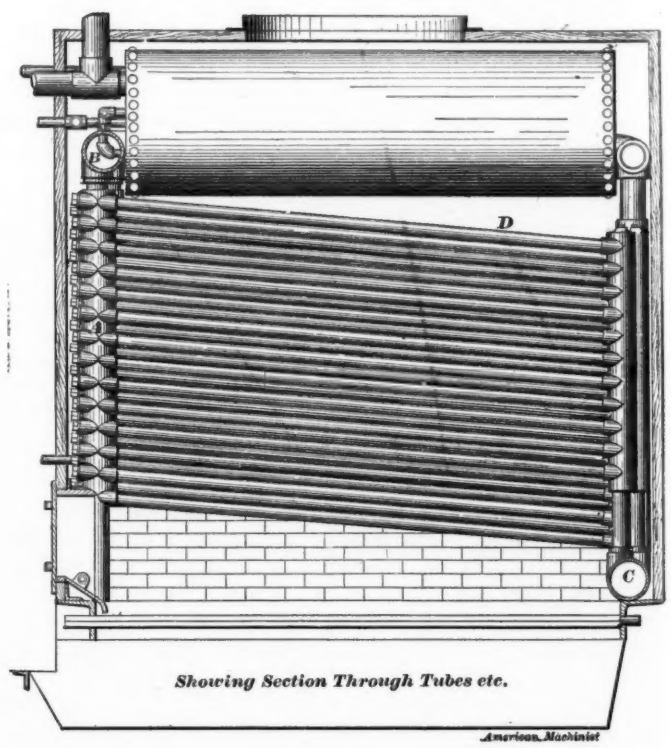


Fig. 3

The West Safety Water Tube Boiler.—See Page 605.

difference of advantage between the intelligent and ignorant workman. Division of labor and special tools facilitate doing the work, while intelligence saves by contriving to attain the object with least labor. The work of the first is seen, the second not so easily, though it is often the greatest factor, as is shown. It is, therefore, to the employer's interest that he encourage a cultivation of science and art among his workmen just as much as improving his machinery and keeping it up to the times. The apprentice should be required to undergo a course of study in the science or art pertaining to his business, and certificates issued as to proficiency at the close of the course as a part of his trade. From an economic view it would pay if such schools were established by the manufacturers of the locality taking a special interest in improving this factor in production generally.

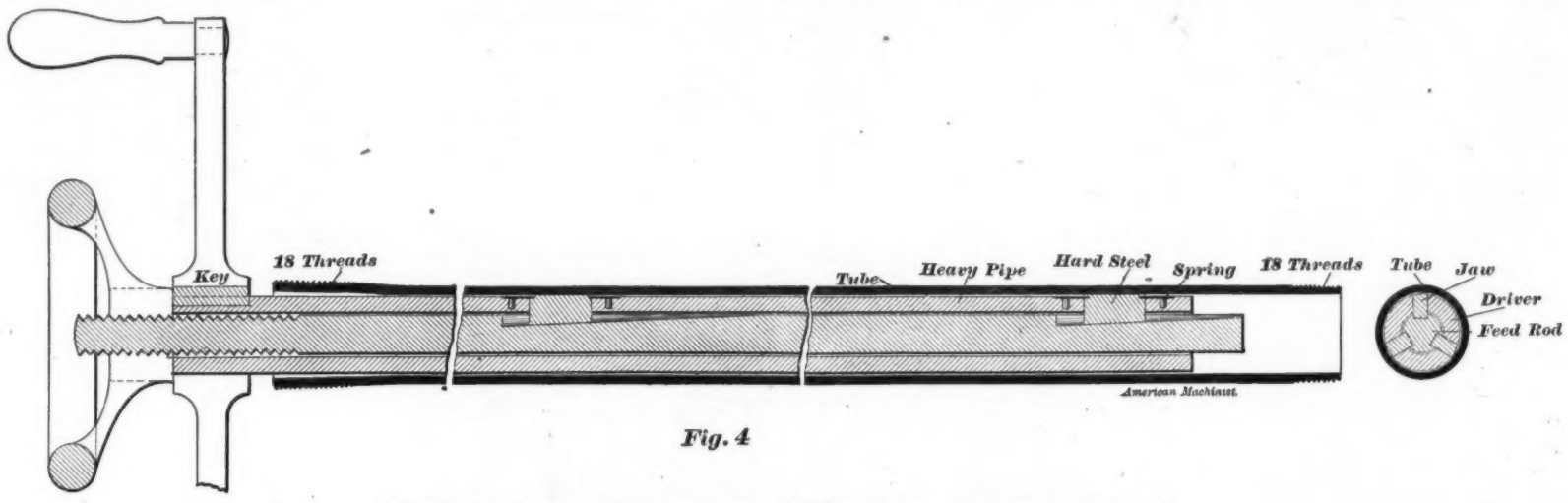


Fig. 4

Expanding Wrench and Tube for the West Safety Water Tube Boiler.

The West Safety Water Tube Boiler.

A distinguished English journal was lately discoursing as follows about things that have hitherto been "good enough:" "Take, for instance, water tube marine boilers. Multitudes of such boilers were invented, and even patented, but no one would look at them. The Scotch boiler was 'good enough.' Something better might perhaps be produced, but no shipbuilder, ship owner, or engineer, would worry himself by trying a new generator when the old answered every purpose sufficiently well. At last, however, a day came when the old boiler was no longer good enough, and now in every shipbuilding town in the kingdom water tube boilers are being made, and half a score of inventors are enjoying themselves after a fashion." It is all right until somebody gets ahead of us, and then we must get the modern improvements in self defence.

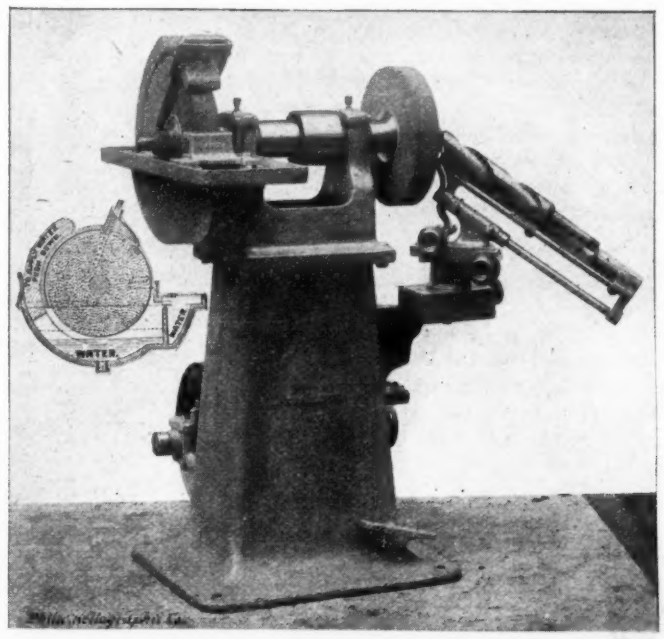
The water tube boiler which we illustrate and describe is built primarily for marine service, but is applicable everywhere. The inventor of the boiler has had a long experience at the Herreshoff Works, and lately with the Gas Engine and Power Co., Morris Heights, New York City, the well-known builders of naphtha launches, and who are now to build this boiler.

Fig. 1 gives a good general idea both of the construction and the appearance of this boiler, one of the plates of the front being removed. The steam pipe emerges at *A* with a branch for the safety valve at *B*, and the feed water enters at *C*. These and other particulars may be changed or modified to suit the circumstances. Fig. 2 shows the boiler with the entire front removed, and Fig. 3 is a longitudinal sectional elevation showing the arrangement of the tubes. The several vertical manifolds *A*, *A*, *A* are connected either to the front horizontal manifold *B* or to the back one *C*, and the water tubes *D* are connected to the upright manifolds at both ends. All of the tubes are alike and are absolutely interchangeable, and any spare tubes would of course replace any tube that might give out. The water tubes have a pitch downward and backward of about five degrees. The forward end of the tube, as will be seen by Fig. 4, is enlarged and it has a thread on each end. The tube is inserted or removed by passing through the front manifold. For screwing the tubes in or out a special wrench is provided which will be understood upon a glance at Fig. 4. This is an expanding wrench and is used inside the tube. It is first slipped into place, when a little tightening of the hand wheel draws the central rod forward and the tapered bearings upon it distend the hardened steel jaws, and the necessary force may then be applied to the lever handle to screw the tube in or out. Slacking the hand wheel and pushing the central rod back immediately releases the wrench. The tubes at each side of the boiler, it will be seen, extend lower by five rows than those in the center. The feed water passes through a coil in the top of the boiler case, where it is heated by the spent gases just before they emerge to the atmosphere. A special valve provides that the water may go directly into the boiler instead of through the coil if anything about it should give out. The coil may be removed bodily by taking off the front top section of the jacket. The jacket is made double, of mild steel, with magnesia block filling, the front being made in sections for easy removal. The grate bars are of square iron with a round bearing turned on the inner end. A socket wrench turns any bar separately for cleaning the fire, and any bar or all the bars may be removed by simply pulling them out endwise. The manifolds are steel castings and are tested to 1,000 pounds per square inch, and the entire boiler is tested to 500 pounds. The circulation of the water is said to be excellent and the quality of the steam furnished is very dry. The boiler works well with forced draught, maintaining a steady water level. The tubes are entirely covered by water when steaming, there are no threaded ends exposed to the fire, they can be cleaned inside their entire length by simply removing the cap in the manifold. The steam drum is of mild steel 60,000 pounds T. S., and is supported by and connected to the boiler by flanges at each end. A line of regular sizes of these boilers will be established and manufactured, but they will also be built to suit any given space or for any special service. Their ready adaptability to widely varying conditions will be evident.

Twist Drill and Tool Grinder.

We illustrate herewith an emery grinder which has attached to one side a special device for correctly grinding twist drills. A knee is attached to the column on which is a slide supporting a socket in which is a stem or rod by which the drill holder is rotated. On this rod is another slide for the purpose of placing the drill in position relative to its diameter, and is operated by a graduated hand wheel, and above that is an arm supporting an inclined shaft, fixing the angle of the drill, and so arranged that by operating a graduated hand wheel, a cam imparts movement of the drill from the center line of the socket and determines the clearance, the whole surmounted by a simple arrangement for holding the drill without the use of a chuck. In operation, the drill is dropped in place, the two graduated hand wheels mentioned turned to figures on their dials corresponding with the diameter of the drill, and grasping the drill holder and drill to keep it in position, it is rotated; then, one lip being ground, the drill is turned over and the other lip ground, both sides precisely alike and requiring but a few moments to put the drill in effective condition. The machine is designed to enable any user of drills to grind them himself and in the least possible time, and, the makers state, has a range from the smallest up to 3 inches diameter. On the other side of the machine general dry grinding can be done if desired, or it can be furnished with the water reservoir and arrangement shown at the left, and which has been previously described. The machine is built by the Appleton Mfg. Co., Thirtieth and Thompson streets, Philadelphia, Pa.

It is rather strange that no American tribunal has defined "dressed" lumber. Rough and dressed lumber enter free under the present law, while "manufactured wood" is subject to duty. A test case has been made to determine whether tongued and grooved flooring and similar stuff comes under the one class or under the other. $50,000,000 of capital are said to be interested in the decision.



Twist Drill and Tool Grinder.

A Railroad Station Indicator.

Many inventors and would-be inventors have thought of a station indicator for railway trains, and quite a lot of patents have been issued for such devices, but, as far as we know, none has ever been permanently adopted. An indicator is to be fitted upon the coaches of the Metropolitan District Railway, London. This railway has about 48 stations and frequent trains, so that the apparatus will have a good test, and, if always reliable, will be a convenience. At a sufficient distance beyond each station, to be clear of the switches, a piece of timber about 4 inches wide by 20 feet long is placed on chairs fastened to the sleepers just in the middle of the track. The ends of the timber are rounded and it has a rise of about two inches from the ends to the middle. A lever, with a roller on the bottom, works on one of the axles, and from this lever run two rods, one to the piston of a small cylinder under the frame and the other to a bell crank transmitting the movement to a vertical rod running up to a shaft on the roof. The cylinder, closed at the end, serves as a regulator, and a spring attached to the upright rod also helps to bring the striking lever back. At the top of the upright rod are bevel gears and a double ratchet wheel so arranged that according to the direction of the train the shaft on the top of the carriage is turned a little to the right or to the left at each movement of the lever. The names of the stations are upon an endless chain which is moved along by the horizontal shaft.

A Safe Burglary that Failed.

A short time ago a press dispatch announced that burglars had blown open the safe of the Ferracute Machine Co., at Bridgeton, N. J., and had secured money and valuables. In reply to our inquiry about the matter, we have received a letter from Mr. Oberlin Smith, in which he says:

I thank you for your sympathy in regard to our burglary, but the newspapers have greatly exaggerated it. When the reporter first got here the knob, dial and other outside members of the lock were knocked off, and two holes were drilled in a somewhat diagonal direction into the heart of the lock. At that time we did not know whether the door had been opened and the contents stolen or not.

We got a safe expert to open the door, and it took him about three hours. Possibly he was not as "expert" as he might have been. Everything was all right inside, and

the burglars, who evidently had intended to open the lock mechanically through the drilled holes, had been foiled by the breaking off of the end of one of their drills, which stuck in the hole and blocked further progress. They did not attempt to use explosives at all, although they might easily have gotten in if they had, as it was only a common "fire-proof."

In this case, fortunately for us, "our friend, the burglar," probably had not read your valuable and interesting articles upon the present state of the development of his art. When I enter the profession, I shall doubtless act with true public spirit and start an Am. Institute of Burglary, and insist upon the members all subscribing to the American Machinist.

A Special Drill and a Tube Cutter for Bicycle Work.

If we are to build a million bicycles next year—and some soaring imaginations have no difficulty in reaching that figure—or if we build no more than 700,000 machines, which it is reasonably certain that we will do, we shall need quite a lot of tools for the work, and special tools adapted to individual operations will greatly facilitate the task. The Fox Machine Co., Grand Rapids, Mich., are doing their share in the equipment of bicycle factories by bringing out some machines that seem to be particularly called for, and two of them we illustrate upon this page.

TUBE CUTTER.

The tubes are cut or parted by a hardened steel disk upon the outer end of the horizontal shaft seen in the cut. The tight and loose pulleys at the other end of the shaft are 8 inches diameter by 2½ inches face, and run at 250 revolutions per minute. The operator stands in front of the machine, handling the tubing with the right hand and the lever with the left. The stop or gage seen near the middle of the machine upon the lower rod is set for the length of the tubes to be cut off. The end of the tube is pushed into the stop gage and the body of the tube is laid upon the two rollers seen under the cutting-off disk. As the lever is moved downwards the rollers are raised, the tube comes in contact with the disk and is quickly severed. The hight of the rollers is adjustable by means of right and left screws for different sizes of tube, so that when the lever reaches its stop the disk will just cut through, and a spring draws the lever back to the vertical position. The tube cannot be crushed out of shape as often happens where a chuck is used.

TWO-SPINDLE RIM DRILL.

This drill is an ingenious arrangement for drilling the spoke holes in the rims of bicycles and is absolutely useless for any other purpose. A special universal chuck centers and holds the rim accurately and firmly. The eight arms with the forks on the ends are thrown out by toggle connections to a central sleeve that is moved forward and backward upon the central stud. The lengths of the arms are changed for different diameters of rim by the substitution of different sets of thimbles seen at the base of the machine. The two drilling spindles running at a high speed are fed down to the work by pulling the central handle attached to two chains that move the operating levers. The drills make the hole for the spoke and also countersink accurately to depth for the washer. While the rim chuck is adjustable for the several diameters of rim from 24 to 28 inches, the drill spindles, drilling for "tangent" spokes, are adjustable for all of the following particulars: Diameter of rim, number of spokes from 20 to 40, length of hub between spoke flanges, diameter of spoke hole circles in hub. When adjusted it need not be said that it does the work with great rapidity.

Some "authority" says: "The diameter of a boiler rivet should be equal to the combined thickness of all the plates it holds together." Circumstances alter cases, knock over a great many rules, and dilute an ocean of wise sayings.

Trying for a Shorter Working Day.

We know a manufacturer, employing 700 operatives, who is busy with experiments to determine the productive unit of a working day, in the hope of being able to diminish the number of the hours of labor in that day. His idea is to ascertain what constitutes a fair day's product, and then to help his employes to fewer hours of labor by requiring from them only that product, turned out as it may be in fewer hours than at present. If nine hours of fresher and more buoyant labor will turn out the same product as ten hours of more jaded labor, he can afford to pay, and is disposed to pay, the same wages for the former as for the latter. His operatives, he believes, by reason of this incentive of more leisure for recreation, will do swifter and better work while they are employed, and the shorter working day will be a boon to them, while it will inflict no loss upon him. In the furtherance of such experiments as this, the improvements which have been made in machinery count as an important factor. These improvements, to a large extent, have taken the direction of increased speed.—*Boston Transcript.*

Drill for Bicycle Rims.

Since the Homestead affair not much has been heard of the Pinkertons, that affair having shown pretty conclusively that, no matter how bad an industrial disturbance might be, it was sure to be aggravated by their presence. That they are still in business, however, is shown by the fact that during a freight handlers' strike at New London, Conn., Mayor Johnston refused to swear in Pinkerton men as constables—said he was satisfied the men who quit work were good citizens, and disposed to obey the laws, and that if the steamboat company wanted to employ special constables from among citizens he would swear them in, but no Pinkertons—all of which goes to show that Mayor Johnston has watched the course of events intelligently, and probably recognizes the fact that the most effective way of promoting ill feeling, disorder, and violence during a strike is to hire Pinkertons.

LETTERS FROM PRACTICAL MEN.

An Endless Rope Water Elevator.

Editor American Machinist:

In the year 1783, there was put in operation in England, an ingenious apparatus for lifting water from deep wells, which was described in the *London Magazine* of that date.

The machine was the invention of a seafaring man "who took the hint from observing the great quantity of water which every rope brought on board with it, that had been drawn through the water; a circumstance that could escape no person's observation who has been much on board ships."

The application of the principle was described as "a grooved wheel, about 3 feet diameter, fixed on an axis, which turns horizontally over the well, and an endless rope of a sufficient length to reach into the well, passes over it in the groove. On the same axis a winch is fixed at one end to turn it by; and, at the other end, another wheel, loaded with lead, which acts as a fly, to increase the velocity.

"On turning the wheel, each part of the rope, as it comes to the bottom, passes through the water, and, on account of the above-mentioned property, the water adheres to, and is brought up by it to the top, where it is discharged from the rope into a cistern placed to receive it, by the pressure of the rope upon the wheel, in passing over it."

This water elevator was erected at Windsor Castle, by command of the king, over a well about 200 feet deep, and, says the writer, "so great is the simplicity and effects of this machine, that we have been told by a very excellent mechanic, who has seen it, that notwithstanding the well is near 200 feet deep, he turned the machine with one hand, so as to raise water sufficient to fill a pipe, the diameter of the aperture of which appeared to him equal to the diameter of the rope that raised it."

We can test this statement by the cold comparison of figures in the following manner: A man's capacity of work being about 2,700 foot-pounds, the load he could lift thereby 200 feet = 13.5 pounds of water per minute. This would emerge under a 1-foot head from a pipe ⅜ inch diameter. (?) As the size of rope employed would be probably nearer an inch, it seems as if the very excellent mechanic had somewhat erred in his observation.

The fact remains, however, that the apparatus was usefully employed, and even under above figures would appear to have shown a good percentage of efficiency.

I cannot find any record of the use of the system since that period, but from its extreme simplicity it would appear to merit some further examination. The action of the lift being by capillary attraction, and the imparting of momentum by the rope strands to the adhering particles, the frictional loss due to 200 feet lift would be almost *nil*, and at a higher rate of speed greater proportionate results might be attained. Reginald Pelham Bolton,
M. Inst. C. E.

Ring and Chain Oiling.

Editor American Machinist:

Mr. Cross is wrong in supposing that I have any prejudice against chain or ring oilers. In my letter (American Machinist June 27th) I conceded that they are in extensive use, and are regarded with great favor. This is, of course, an admission that they are giving satisfaction in many places. But that does not by any means obviate the defects of the system, and so far as my opinions are concerned, they are based upon actual experiences. In our endeavors to meet a demand for chain oilers, we discovered first that a light chain, otherwise ample to convey sufficient oil, was very likely to be arrested by the slightest obstruction, such as touching the box. This is because it has so little traction and so little momentum. We gradually increased the size of the chain so as to get more weight and traction, until we arrived at a chain about the size and style of a bicycle chain. This carried a stream of oil as big as your finger, and as a matter of course, quickly drained the oil reservoirs, so we were compelled to enlarge the reservoirs. It seems to me that a ring must necessarily be inferior to the chain either as a carrier for oil or as insuring the necessary traction, and it must be indisputable that with speeds not at all excessive, centrifugal force causes the oil to leave either ring or chain, and seek the cap, whence it drains back to the reservoir. This was our observation, and it seems entirely in accordance with reason. Hence I conclude that the predilection for chain or ring oilers is a fad.

R. D. O. Smith.

How to Hire Hands.

Editor American Machinist:

An article under above heading appeared in your valued paper of July 11th; the writer of the letter attached to article was evidently very much annoyed because some of his men left him, but we may be quite sure they would not do so without good cause, and it is certain that the last two men that left him fully investigated the matter before quitting, as it would be of the first importance to them that the change should be for the better, and as men have been leaving for sev-

eral years they have good opportunities of seeing the result from actual experience.

In fact, the pretty little article and letter present only one side of the question, and it is quite evident there is another side. The workmen have been trained and specialized "to use," as "Z" expresses it, and they would not have struck if the superintendent used as much "tact" as "Z" would have done. The writer assumes, of course, that he is altogether right, working for the benefit of the public, etc., but the system as shown is the taking a man and making him skillful at one thing; then he is supposed to stay right there, happy and contented forever; this is where the hitch occurs, human nature was not built especially for the factory system, and most of us have not the faculty to "stay put," however much it might be for the interest of the employer.

Then the pay is taken into consideration, but, after all, a little difference in pay would not warrant a man in changing his position; it is the monotony of his work he wants to get away from, and in a new field there is always a chance of some change, and if it is only a change of place and scene, that is something.

Factory work is monotonous in the extreme, it aims to make a human being a machine, the human, in its own way and time, rebels, hence poor "Z's" difficulty and wail. It is human nature, not pay, or some exterior influence he has to contend with; broaden the work and the minds of employes; don't study the interests of the public quite so much (and, incidentally, the pursuit of the almighty dollar), and men won't be quite so ready to leave even an irresponsible and soulless corporation. WHY NOT?

Chicago.

The Cost of Castings.

Editor American Machinist:

Among the prescribed duties appertaining to the position I hold, is one requiring an accurate statement of the cost per pound of the castings we make. If you will kindly advise me if I am right in the following analysis of one of our heats, or if wrong, will indicate the proper method, I will appreciate the same:

CHARGE.

300	pounds	pig .0066 cost	$ 1.98
710	"	car wheel .005	3.55
3,800	"	scrap .0045	17.10
870	"	sprues .0176	15.31
5,680			$37.94
650	pounds	coke,	26 00
		Labor.....	36 00
			$99.94

RESULT.

3,945	pounds	good castings.
575	"	bad "
572	"	gates "
200	"	dump
5,292		
388	pounds	loss.
5,680		

3,945 pounds good castings into $99.94 = $0.0253+ per pound. Now, of course, there is a credit on this of the amount of iron in bad castings, gates and dump = 575 + 572 + 200 = 1,347 pounds.

The amount of metal recovered from cupola being 5,292 pounds, and the cost $99.94, makes the cost of metal recovered = $0.0188 + per pound.

Is this cost per pound the value per pound of the 1,347 pounds noted above?

This is the rule I have been following, and in making the cost of the cupola charges I have charged the sprues at the cost per pound, as so ascertained from the previous heat.

This may be a simple matter to some, but it has provoked some criticism here, and I want some one in authority to decide the matter. The large per cent. of bad castings was no fault of the molder, but due to a breakdown of blowing apparatus.

What would be the proper amount of limestone or shells to put in such a heat to flux it properly, and when should they be charged? If convenient please publish a blank form for keeping a cupola account, and oblige. A BLOCKHEAD.

[It seems to us best to place the above interesting inquiry before our readers, without attempting an authoritative decision in the matter. It is evident, however, that our correspondent's practice is incorrect, and that it might produce some queer results. In the cost of the iron in the original charge, the pig-iron is .0066 per pound, car wheel .005, scrap .0045 and sprues .0176. Here the value of the sprues as given is nearly four times as great per pound as the mean price for all the rest of the charge. The sprues evidently are charged much higher than their actual value. So too in figuring up the results of the cast it is plain enough that the good castings are worth more per pound than the bad castings and sprues, but the actual result of our correspondent's method is that they are worth just the same. Why would it not be more correct to fix a standard price for the sprues approximately representing their actual value at the cupola? Say that we make them .005 per pound, and apply that value in the above case. We then have:

Iron 5,680 pounds, cost...	$26.95
Coke and labor	62.00
Total.....	$88.95
Deduct 1,347 pounds at .005.....	6.74
	$82.21

$82.21 ÷ 3,945 pounds good castings = $0.0208 per pound.—ED.]

Graphical Methods of Calculating.

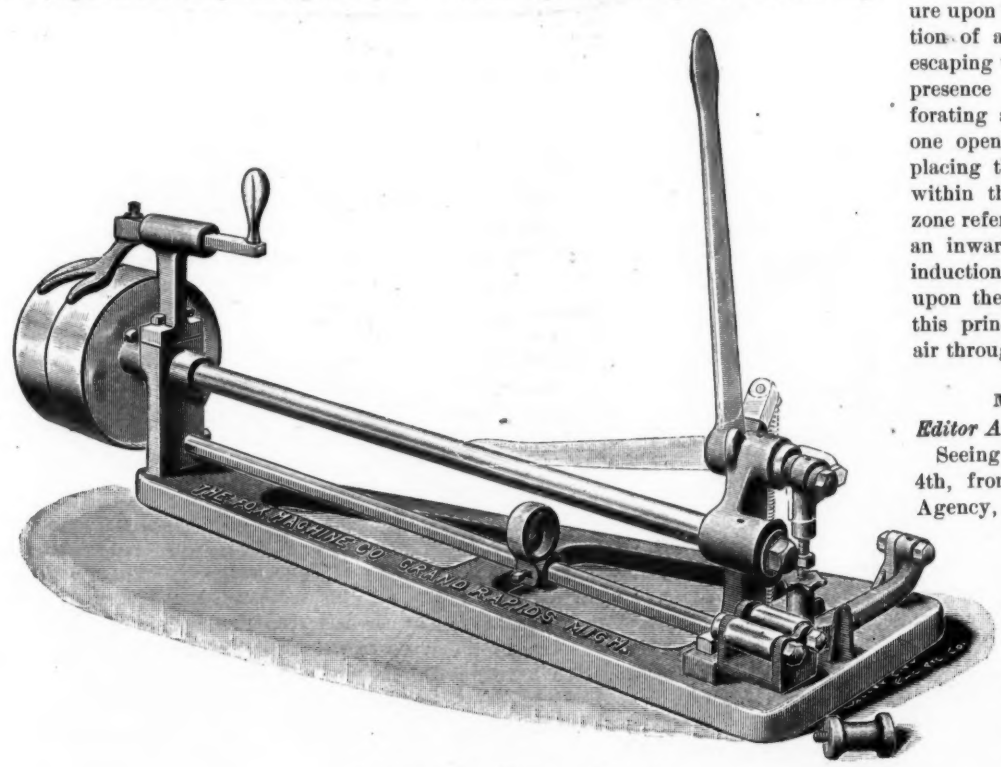
Editor American Machinist:

The graphical methods of finding square roots, squares and reciprocals, given by Mr. R. E. Horton, in your issue for May 16th, appear to me to be needlessly complicated, and I venture to think that he will find the following construction superior in many respects to the several solutions he submits.

In the sketch, $O\ C$ is a line on which lay off $O\ B = 1$. At B raise a perpendicular, and from O as center and length = N, cut this perpendicular in A. Join $A\ O$ and draw $A\ C$ and $D\ B$ both perpendicular to $O\ A$, and $D\ E$ perpendicular to $O\ C$. Mark off $O\ h = 1$, and draw $h\ k$ perpendicular to $O\ A$. From x, the middle point of $O\ A$, draw the arc $A\ k$ and join $k\ O$. Then $O\ k = \sqrt{N}$; $O\ l = \sqrt{\frac{1}{N}}$; $O\ C = N^2$; $O\ D = \frac{1}{N}$ and $O\ E = \frac{1}{N^2}$. This construction may be continued in both directions. Thus, by drawing from E a perpendicular to $O\ A$, we obtain $O\ f = \frac{1}{N^3}$, and so on, the *odd* negative powers being obtained on $O\ A$ and the *even* negative powers on $O\ C$. In the other direction, by raising a perpendicular at C, cutting $O\ A$ produced in g, we obtain $O\ g = N^3$, and continuing in this way, the successive positive powers of N can be obtained, the *odd* powers being always found on $O\ A$ produced, and the *even* powers on $O\ C$ produced. As will be seen, the above construction supplies in one simple diagram all that Mr. Horton required, and a good deal more. Nevertheless, I question very much if the most suitable applications of graphic construction are found in applying it to the solution of such a problem as that which your contributor refers to. Since it is shown that a close approximation to absolute accuracy was sufficient for the purpose, Mr. Horton would have found the slide rule of far more value than his drawing board. With the modern instrument (Mannheim type) the procedure is very simple, and consists in inverting the slide, and placing the end indices coincidently. Any value of $\frac{1}{N^2}$ is then read off on the A scale over the value of N on the C scale. Nothing can be simpler than this, as Mr. Horton will discover very speedily.

There is, no doubt, a necessity for carefully discriminating between the various methods of solving such problems as are of more or less frequent occurrence in the drafting room. For many purposes the slide rule is of the utmost possible assistance, but it is easy to find instances where it is totally unsuitable, or at best but ill-adapted. The same may be said of graphic methods of calculating, for it cannot be gainsaid that one or two of the complicated diagrams which occasionally adorn the pages of some of the electrical journals, afford abundant evidence of the inadaptability of this method of solving certain of the problems which are met with by the electrical engineer. At the same time, much useful work may be accomplished by the *reasonable* use of the graphic method of calculating, and there is no doubt that much greater use will be made of it in the near future. With the graphic *diagram*, the engineer has now become perfectly familiar (although the fullest uses are not yet made of it, as I hope on another occasion to show) and the further development of graphical calculation will doubtless follow as a matter of course.

M. E.



CUTTING OFF BICYCLE TUBES.

Radial Icicles—A New Hose Sprinkler.

Editor American Machinist:

Water on a revolving body, as a grindstone or emery wheel, always leaves it when due to centrifugal force, at a tangent to the circumference, but if the water freezes as it flies off, the icicles are radial, as may be seen on many parts of a rolling mill in cold weather. I beg to inquire of any of your readers, and more particularly of Mr. Porter or Mr. Begtrup, who have written such excellent letters for these columns, on centrifugal force, to explain why the icicles are formed radially, rather than some other shape—a spiral, for instance.

There is a new hose sprinkler on the market that gives results so contrary to what one would expect that I submit its action to your readers, hoping to find some one who will explain the phenomenon. The sprinkler consists of a tapering nozzle, and a ball that fits about the middle of the taper. The small end of the nozzle is connected to the hose. The sprinkler that I made to test the accuracy of a report that I read of the sprinkler in a Pittsburg daily, was made for ½ inch fitting, and the nozzle tapered about 55 degrees, and the ball made of dry pine ⅜ inch in diameter. When connected to the hose, and the water turned on, the ball whirls around rapidly in the nozzle, and, although there is nothing to keep the ball in the nozzle, to all appearances at least, it stays there against the action of the water, and the force of gravity combined. If the nozzle is held with the large end up and the ball dropped in, and the water turned on very slowly, the ball rises with the water, and falls over the edge of the nozzle just as would be expected, but if the water is suddenly admitted, the ball stays at the bottom of the nozzle (but allows a circular sheet of water to pass out), with the nozzle held in any position, and at the same time jerked violently, to help loosen the ball from the small end of the nozzle.

The action of this sprinkler is the same, as far as can be seen, whether air or water pressure is used. The question is, what keeps the ball in the nozzle?

Youngstown, Ohio. J. H. DUNBAR.

[The *Scientific American* in a recent article upon the ball nozzle attributes the retention of the ball to unbalanced air pressure upon its outer surface due to the formation of a vacuum at the zone when the escaping water is tangent to the ball. The presence of this vacuum is proved by perforating a ball attaching a flexible tube to one opening of the perforation, and then placing the other opening in such a position within the nozzle as to come within the zone referred to. It is found that there is an inward current in the tube caused by induction. For several years there has been upon the market a toy which makes use of this principle. It is operated by blowing air through a short tube.—ED.]

Making Small Punches.

Editor American Machinist:

Seeing an inquiry in your issue of July 4th, from the Asa P. Hyde Machinery Agency, concerning their breakage of small punches, I think their principal trouble is in making the working part of punch too long.

My practice is to make small punches one and a quarter diameters long, and have working part free from tool or file marks, slightly relieved and with plain, flat face. A punch made this way should give all service that ought to be expected from such a small tool. JNO. ILLINGWORTH.

Mobile, Ala.

A Collision that was Avoided.

The scheme which we believe was first proposed by Stirling Elliott years ago of having two locomotives collide on a straight piece of track when going at full speed, and to make an exhibition of the collision, was on the program to take place at Canton, Ohio, on the 20th inst., and the two locomotives, one an eight-wheel passenger type, the other a freight with three pairs of drivers coupled, were placed opposite each other with steam ready for the contest, when it was discovered that the man who was managing the affair failed to so arrange his fences that he could collect an admission fee from more than a small fraction of the people who were in position to witness the spectacle, and as, on account of this, he lacked the necessary funds to pay for the locomotives, the affair was called off. It is expected, however, that such an occurrence may take place in the future under different, and we hope, wiser, management.

AMERICAN MACHINIST

PUBLISHED EVERY THURSDAY

BY THE

AMERICAN MACHINIST PUBLISHING CO.,

203 BROADWAY, NEW YORK.

Fred J. Miller, Pres't. Chas. W. Biglow, Treas.

C. A. Hansmann, Sec'y.

Fred J. Miller, Editor.

Special Announcements.

☞ *We publish nothing in our reading columns for pay, or in consideration of advertising patronage Space in the advertising pages only is for sale.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent on subjects pertaining to machinery.*

☞ *Every correspondent, in order to secure attention, must give his full name and address; not necessarily for publication, but as a guarantee of good faith.*

☞ *All communications for, or relating to the reading columns should be addressed to the editor. All other communications to the company, as above.*

☞ *Subscribers can have their mailing address changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

☞ *The* ***American Machinist*** *is not interested in any particuar patents, products or factories, to the prejudice of others, but is devoted to the interests of all those who have to do with designing, building, selling and using machinery.*

☞ *Back volumes of the* ***American Machinist*** *for any of the fourteen years, 1880 to 1894, inclusive, may still be obtained. Price unbound, $3.00 per volume postpaid; bound in cloth, $4.00 per volume.*

Subscription.

$3.00 a year in advance, postage prepaid, in the United States, Canada, and Mexico.

$4.00 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.

"Business Specials," 50c. a line.

The American News Company,

New York, is the Publisher's Agent, and dealers are supplied by all its branches throughout the United States and Canada.

For Europe:

The International News Company, Bream's Bldg's, Chancery Lane, London, E. C., Eng., will receive subscriptions for the American Machinist at 16/6 per annum, English currency, or 17 marks per annum, German currency, postpaid.

Subscriptions received in Paris, France, by E. Terquem, 31 Boulevard Hausmann, at 21 francs per annum, postpaid. Subscriptiols received in Australia by W. Williams, 17 and 21 Fink's Buildings, Melbourne.

Continental Office:

LEIPZIG, Germany. Oscar Neuman, 27 Elster Str.

Chicago Office: 206 La Salle St.,

Wm. D. Mahaney, Agent.

New England Office:

Providence, R. I., 127 Pleasant St.

John A. Walker, Agent.

NEW YORK, AUGUST 1, 1895.

CONTENTS.

	PAGE.
The Hornsby-Akroyd Oil Engine	601
A Piece-Rate System—II. By Fred. W. Taylor	602
Time Required to Stop Trains by the Air Brake	603
Economy in Pattern Work. By I. Whitehead	604
The West Safety Water Tube Boiler	605
Twist Drill and Tool Grinder	605
A Railroad Station Indicator	605
A Safe Burglary that Failed.	605
A Special Drill and a Tube Cutter for Bicycle Work	606
Trying for a Shorter Working Day	606
Letters from Practical Men: An Endless Rope Water Elevator. By Reginald Pelham Bolton ....Ring and Chain Oiling. By R. D. O. Smith ... How to Hire Hands. By Why Not?.... The Cost of Castings. By A Blockhead.... Graphical Methods of Calculating. By M. E. ....Radial Icicles—A New Hose Sprinkler. By J. H. Dunbar....Making Small Punches. By Jno. Illingworth	606, 607
A Collision that was Avoided	607
The Cost Account.	608
The Problem of the Brake on the Trolley Car	608
Lathe Foot Stocks	608
Some Bicycle Designs	608
Literary Notes	608
Questions and Answers	609
Early Engineering Reminiscences—I. By George Escol Sellers.	609
Adiabatic Curve Construction—Uses of Logarithmic Section Paper. By M. E.	611
Electricity on Railroads	611
New Catalogs	611
Manufactures	611
Machinists' Supplies and Iron.	612

The Cost Account.

Nothing seems more certain than that there will be times of business depression like that from which we are just emerging, and we wonder how many builders of machinery are in the habit of making allowance for this fact when making up their cost sheets.

If shop expenses, or fixed charges, amount to, say, fifty per cent. of the labor cost of a given job when the shop is running full handed then it is evident they must amount to much more than this when only one-half or one-quarter the full number of men are at work, which is usually just the time when the lowest price must be accepted for the finished work.

No cost system we have ever heard of takes account of this variation in proportion of fixed charges, and yet unless it is provided for in some way—unless there is sufficient margin in good times to cover the deficiency of times that are not so good, a term of years will certainly show a net loss in the business. Of course it is true that machinery must usually be sold for what it will bring rather than for what the builder thinks it ought to bring, but it is pretty certain that competition would not force prices quite so low at times if it were better understood that the same prices which afford a fair margin when times are good probably will not do so when times are bad, and that machine building is not like the pop-corn business that can readily be abandoned at short notice, but must give average good results through a term of years or be classed as unsuccessful. In view of these considerations is it quite so certain as it sometimes seems to be that cost systems really show the actual cost of machine construction?

The Problem of the Brake on the Trolley Car.

The multitude of electrical publications is now so great, so much talent is employed upon them, and so much enterprise is displayed by them, that between them all we should at least be able to get at all the important facts connected with the matters which they professedly handle. As it is their mission to disseminate knowledge, to promote investigation, to chronicle the results of investigation and experiment, and in a manner anticipate for the uninitiated the progress and development of the modern wonder, we had hoped before this to have seen something of the topic indicated by the title above. We have been waiting very patiently and looking very longingly for some solution of the perplexing problem of how to operate the brake upon the electric car, so that an electrically propelled car shall be as safe as any other, so far as the stopping of it is concerned. We have not seen that problem considered, or even enunciated by any electrical journal. Why not? It is not to be supposed that any electrical journal is ignorant of the fact that an electrically driven car upon a street railway, a trolley car, either an overhead trolley, or an underground trolley, and especially, and, for an additional reason, a car operated by a storage battery, cannot either of them, with safety to itself, be stopped as quickly as any other car of the same capacity, and running at the same speed. Instantaneous brakes can be applied to any car, they are used upon cable cars and others, but they are not used upon electric cars, and are not likely to be so used. While the safety of the public imperatively demands that a car shall be stopped as quickly as possible, the safety of the car mechanism demands that there shall be no such instantaneous stoppage, and, of course, the safety of the car is the prevailing consideration rather than the safety of the child that is caught under the front of it. If anyone will take a little trip upon a trolley car, and watch the operation of the brake, he can easily get the impression that the brake is purposely designed to be applied with some deliberation, and cannot be applied in any other way. The brake cannot be put on as quickly as the current can be thrown on or off. For operating the brake a long crank is provided, and a complete revolution of the crank is required before the brake begins to bite, while the full pressure is applied by a series of ratchet movements given after. Besides this it is at least possible that in some emergencies motormen have been confused and "rattled" and have turned the crank the wrong way, and have failed to apply the brake at all. Any mechanic must see at once that the brake, in view of the emergency that it is supposed to provide for, is a slow-acting affair, and if he will investigate the propelling mechanism of the car he will easily see that it is, and why it is, purposely made so. The armature of an electric motor, as everybody knows, is quite a heavy part of it, and, running at a high velocity, it is, of course, a powerful fly wheel, and when it is noticed that the armature, or the shaft which carries it, is geared to the axle without the possibility of slip the whole situation is exposed. If the axle is stopped suddenly something is going to be smashed, so the slow-acting brake is a safety device for the motor.

We have been wondering for some time, why this matter has not been brought to the attention of the public, so that the real state of affairs could be generally understood, and so that the remedy might be sought in the right direction. The voluminous discussion about car fenders has not helped to promote the permanent safety of electric traction. Common sense unaided can determine that an instantaneous brake is a necessity in connection with rapid transit, and it should be insisted upon. The rearrangement of the motor mechanism by the application of friction clutches or other devices could be accomplished by many an engineer of the day, so that there is nothing impossible to be demanded. In calling attention to this matter we feel that we are promoting rather than retarding the safe and permanent establishment of the electric motor, and that we are more truly its friend than are any of those who hesitate to tell the whole truth about it.

Lathe Foot Stocks.

If we were to try to make a foot stock for a lathe in such a manner as for a given weight to be least able to bear the stresses to which it is subjected in use, we can not, at the moment, think of a more effective way of accomplishing it than to copy the regular English design, unless it might be to perch the barrel upon top of a single upright instead of two. Ever since carpenters began making gates with a diagonal brace extending from one lower corner to the opposite upper corner of the frame to take the thrust and keep the gate from sagging by its own weight, it has been understood that a rectangular frame held by one of its sides to resist a stress applied at and in line with its opposite side is very weak in proportion to the material used in its construction. A properly arranged diagonal brace adds strength out of all proportion to the material required, but a better plan in this case would seem to be to follow the American design and make the foot stock a box. This form is very stiff in proportion to its weight, and, if objected to on account of its width interfering with the use of the slide rest, then it could still be a hollow section but narrower, as in fact it has been made by one firm here for a number of years, an eccentric being employed for fastening it to the bed.

This subject of fastening of foot stocks leads us to wonder what those people are thinking of who make a foot stock with a single bolt, fastening it to the bed and then place that bolt about as near the rear end of the stock as they can get it, instead of near the front, as it should be. In a certain shop in the far West, we found one of these lathes with the holding-down bolt arranged in this way. At first we thought it must connect with a lever reaching forward to a point near the front of the block, but upon finding that it was just a plain bolt going through the ordinary clamp below, we asked the man who had it in charge how he liked the lathe. "First rate," he said, "only sometimes there is some trouble when taking a heavy facing out near the tail center;" and he showed a rigging made of two clamps and two bolts; one clamp he placed across the top of foot stock near its front end, the other clamp crossed under the bed and the two clamps were connected by the two bolts, one in front and the other at the rear, and tightened. This rig he put on whenever he wished to take what he called a heavy cut, though as a matter of fact no heavy cut could be taken on the lathe, which was about 10 inches or 12 inches swing. The designer of that lathe must have thought that foot stocks are subjected to stresses in line with the bed only, and that nothing tends to lift them from it—or else, perhaps, he just didn't think at all about the matter.

Some Bicycle Designs.

There is evidence that some of the bicycles now being made are designed by men who would be the better for a little of the "book learning," which, perhaps, they despise as "mere theory."

We saw a ladies' wheel the other day which had two pieces of tubing, one above the other, extending from the steering head to the crank hanger, and the lower one of these two tubes was about as large in diameter as the upper one.

If the designer of that wheel had known that the upper member of this truss would be in compression when loaded and the lower member in tension, then, perhaps, he would also have known that the smallest tube should have been below and the largest one above—just the reverse of his arrangement.

However, as a matter of fact, a bicycle frame is subjected to so many and so varied accidental stresses that a rigid adherence to rules laid down for ordinary structures would, of course, not be judicious. In case of a front collision, for instance, the stresses in the frame would be just the reverse of those imposed by the ordinary load, and this fact taken with the further fact that some lateral rigidity is important makes it probable that only wide experience and observation of wrecked wheels can give the proper proportions. Manifestly wrong constructions, such as mentioned above, ought, however, certainly to be avoided.

In our issue of June 7, 1884, there appeared an article entitled "Early Engineering Reminiscences," by Geo. Escol Sellers, member of a family of notable engineers. This article was followed by nine others during that year, all of the greatest interest and showing a remarkably good memory of events, and a remarkable ability to describe them in an interesting way; more particularly when it was considered that the writer was then in his seventy-sixth year. In the intervening years our readers have occasionally heard from Mr. Sellers, but not recently, until now, in his eighty-seventh year, he again takes up his pen, and we publish elsewhere in this issue the first of another short series of articles from him, feeling quite sure that our readers will join us in heartily welcoming him to our columns, and in the hope that he may be granted time and strength to write much more for us.

Literary Notes.

We have received Volume XI. of the "Transactions of the American Institute of Electrical Engineers." It contains full reports of their annual, general, and regular meetings held during the year 1894. The papers presented at these meetings, and the discussions which followed them, are of great interest and value to the profession, and fully maintain the standard which has been set for these meetings. The volume contains 938 pages, with a folding sheet giving "the diseases of dynamos," their cause and remedies, compiled and arranged by C. D. Parkhurst, 1st Lieut. 4th Artillery, and a member of the institute. The subjects on this sheet are diagramically arranged, so that disease, cause and remedy

can easily be traced. The whole work is very neatly gotten up, and with the high character of the subjects which it contains, will be a valuable addition to the engineers' library. It is published by the institute at its office, 26 Cortlandt street, New York.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(293) W. M. R., Berwick, Pa., asks: Are there any works published which treat on blacksmith work? *A.*—Six volumes treating on practical blacksmithing have been published by M. T. Richardson, editor of the *Blacksmith and Wheelwright*, New York. These books cover a large field of this class of work, and will probably suit you.

(294) J. M. D., San Francisco, Cal., writes: Please give a method of computing force which a spiral spring can exert; I mean a spring wound like a watch spring. *A.*—The force which a spiral spring can exert can be computed by the following formula:

$$P = \frac{S}{6} \times \frac{b \times h^2}{R},$$

in which P = force in pounds exerted by the spring, S = stress in pounds per square inch in the steel, the value of S will depend on the quality and temper of the steel, 24,000 pounds will probably be a fair average, b = the width of blade in the spring, h = its thickness, and R the distance in inches from the center of the spring to the point of application of the force.

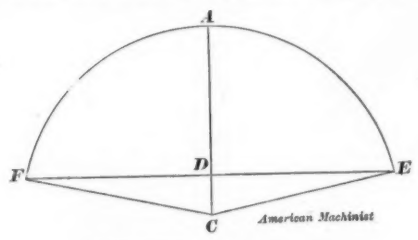
(295) J. Y., Hamilton, Canada, writes: I have charge of a 25 horse-power boiler; the water which we use is taken from the lake, and filtered through a bed of sand; it is very clean water, but for all this, considerable scale accumulates in the boiler, especially on the tubes. Please inform me what substance will dissolve it. I have been told by those who examined the scale that it is common lime. *A.*—Half a pint to a pint of kerosene oil per day fed into the boiler, according to the quantity of water evaporated, will, we believe, show good results. Do not use crude petroleum; it is too heavy, which, when it mixes with the impurities in the water, may form a paste, and stick to the heated plates and cause injury to the boiler. If kerosene is used, the glass water tube should not have rubber packing, as rubber and kerosene do not agree. Use asbestos wicking dipped in boiled oil, and then squeezed dry for packing. Blow off frequently.

(296) T T., New York, writes: For the purpose of experimenting, I would like to know which of the two metals, lead or zinc, will stretch the most, and how much they will stretch when heated. *A.*—The ultimate tensile strength of cast-lead is about 1,800 pounds per square inch, and that of sheet lead about 3,350 pounds per square inch. The ultimate tensile strength of cast-zinc is from 3,500 to 7,000 pounds per square inch, and that of sheet-zinc from 7,000 to 16,000 pounds per square inch. These materials are seldom if ever used for any member of a structure of any kind which is subjected to a tensile stress, consequently the tensile strength and elongation of these materials are of very little importance to the engineer, and therefore not as much attention has been given to determine this data as has been given to steel, iron, etc. Any attempt to give the elongation of these metals under any given condition will be not much better than guesswork. The only way to obtain reliable information on this subject is to make the experiments yourself.

(297) C. J., Harrisburg, Pa., writes: Please furnish me with a formula for making a solution for oxidizing brass to a good black color by simple immersion. It will have to work quick, and not be too expensive. The work will have to be handled some before it could be lacquered, so it will be necessary that it does not rub off easy. The expense of the solution, of course, will have to be governed by the quality of the work, only requiring that it be within a reasonable amount. *A.*—The following solution is recommended for obtaining a deep black color on brass: Dissolve 100 parts of copper nitrate in 100 parts of water. If the article is large, then paint it with this solution; if small, immerse it in the solution. After draining off, or shaking off the excess of the solution, heat the article until the copper salt is decomposed into a black copper oxide. The work may be heated over a clear coal fire, but better results may be obtained by heating the articles in a closed muffle furnace. For some kind of work you may obtain more uniform results by using a weaker solution than given above, namely, 100 parts of copper nitrate to 300 parts of water.

(298) S. R., Philadelphia, Pa., writes: We have an upright boiler with 180 tubes. Some of these have been leaking off and on for nine months. I have had them expanded but this does not seem to do much good. Being very busy I should like to know if these tubes can be plugged without any bad results. There are about twenty leaky tubes in all, located in the center of the boiler. The boiler has not been cleaned for a few weeks past. There may be considerable scale collected around the tubes. I did not remove them, thinking it would cause a greater leak. *A.*—You can plug up the leaky tubes, but it is difficult to say what the results will be. If the aggregate area of tube opening is one-seventh or less than this of the grate area, the steaming capacity of the boiler will be reduced by plugging so many flues, because the draught will be reduced, and, consequently, the coal which can be burnt will be decreased. There is also more or less danger of blowing some of these plugs out which may be accompanied by disastrous results. It is dangerous practice to allow scale to collect around the tubes for the sake of decreasing a leak. Our advice is to put in new tubes as soon as possible, and make stay tubes out of three or four of the central tubes.

(299) F. K., St. Louis, Mo., writes: Kindly give me a solution of the following problem: The hight of a segment of a circle is 23 inches, the radius of the circle is 30 inches, find the area of the segment. *A.*—To find the area of this segment we first find the area of the sector $A\ F\ C\ E$, and from this subtract the area of the triangle $F\ C\ E$, the result will be the area of the segment. The first step will be to find the length of $D\ E$ which is equal to one-half the chord. The hight $A\ D$ of segment is 23 inches, consequently the altitude $D\ C$ of the triangle $F\ C\ E$ will be $30 - 23 = 7$ inches. Now to find the length of $D\ E$, square the length of $C\ D$ and subtract this from the square of the radius $C\ E$, and find the square root of the remainder, the result will be the length of $D\ E$; thus



$$\sqrt{30^2 - 7^2} = 29.17 \text{ inches},$$

which is the length of $D\ E$. The next step will be to find the number of degrees in the angle $F\ C\ E$; to do so we first find the sine of the angle $D\ C\ E$ by dividing the length of $D\ E$ by the radius $C\ E$, thus

$$29.17 \div 30 = 0.9723,$$

which is the sine of the angle $D\ C\ E$; looking for this sine in a table of natural sines, tangents, etc., which can be found in any engineer's pocket-book, we find that the number of degrees corresponding to this sine is 76; consequently the angle $F\ C\ E$ will contain $76 \times 2 = 152$ degrees. We are now in a position to find the area of the sector $A\ F\ C\ E$, which is done by multiplying the area of the whole circle by 152, and dividing the product by the number of degrees in the whole circle, namely, 360. The area of a circle 60 inches diameter is equal to 2,827.4 square inches; hence the area of the sector will be equal to $\frac{2{,}827.4 \times 152}{360} = 1{,}193.79$ square inches. The area of the triangle $F\ C\ E$ is equal to $29.17 \times 7 = 204.19$ square inches, and the required area of the given segment will be $1{,}193.79 - 204.19 = 989.6$ square inches.

(300) H. G., Bristol, Conn., writes: Please give a formula for computing the size and dip of buckets for paddle wheels on vessels. I have never had anything to do in this line, and am not certain if displacement forms the base of computation, or some other point. *A.*—The following refers to ordinary wheels with radial floats or buckets. First, find the area of the float by the following formula:

$$A = \frac{I.\ H.\ P.}{D} \times C.$$

In which A = area of the float in square feet, $I.\ H.\ P.$ = the total indicated horse-power, D = effective diameter in feet; this is usually measured from the centers of opposite floats, and C = a multiplier varying from 0.25 in tug boats to 0.175 in fast running light steamers. The breadth of the float is usually about $\frac{1}{4}$ its length, and its thickness is about $\frac{1}{8}$ its breadth. The number of floats varies directly with the diameter, and there should be one float for every foot of diameter. From the above, we can find the dimensions of the buckets for a radial paddle wheel. Example: Find the dimensions of buckets for a paddle wheel whose effective diameter is 14 feet, and the indicated horse-power is 322.

$$\text{Area of float} = \frac{322}{14} \times 0.25 = 5.75 \text{ square feet.}$$

$$\text{Length of float} = \sqrt{4 \times 5.75} = 4.8 \text{ feet.}$$

$$\text{Breadth of float} = \frac{4.8}{4} = 1.2 \text{ feet.}$$

$$\text{Thickness of float} = \frac{1.2}{8} = .15 \text{ foot or } 1.8 \text{ inches.}$$

Number of floats, 14.

When a vessel works always in smooth water, the immersion of top of float should not exceed one-eighth of the breadth of the float; and for general sea service an immersion of one-half the breadth of the float is sufficient. If the vessel is intended for carrying cargo, the immersion when light need not exceed 2 or 3 inches, and should not be more than the breadth of the float when at the deepest draught, as the efficiency of the wheel falls off rapidly as the immersion increases.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 612.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Marine Iron Works, Chicago (new catalog).

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

Air compressors for all purposes and pressures. Clayton Air Compressor Wks, 28 Cortlandt St., N.Y.

Foster Engineering Co., Newark, N. J., Pressure Regulators, Reducing Valves, Pump Governors.

Wanted—Machinery to build: special, steam, mill, hydraulic. F.C. & A. E. Rowland, New Haven, Conn.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

Do you want Brass or Aluminum Castings—Large or Small? Write me for prices. Twining Campbell, Brass and Aluminum Founder, Liberty street, Paterson, N. J.

New and valuable book, "Hawkin's Aids to Engineers' Examinations," with questions and answers; leather bound, gold edges, $2 postpaid; catalog. Theo. Audel & Co., 91 Liberty St., N. Y.

Machine work solicited; complete equipment modern machine tools; patternmaking, designing, experimental work; tech. assistance if required; best facilities & very reasonable prices. P. Pryibil, 512-524 West 41st St., N. Y. See page 616.

Just Published—"The Modern Machinist," by John T. Usher. Price, $2.50. Each of its 257 illustrations represents a new device in machine shop practice; a new book from cover to cover; agents wanted in every machine shop; send for special illustrated circular, Norman W. Henley & Co., 132 Nassau street, New York.

Early Engineering Reminiscences—I.

BY GEORGE ESCOL SELLERS.

As I am now in my eighty-seventh year, and feel the growing infirmities of age, the time seems to have come when I should be preparing my valedictory. I am frequently questioned, both verbally and by letter, as to what, after a long life spent in mechanical pursuits, has induced me to come South and settle down on this spot, and by those of my friends who have visited me here, how I ever came to find and select so beautiful and restful a place. To answer these queries may not be in a line proper for the AMERICAN MACHINIST, it being a paper devoted exclusively to mechanics, but it seems due to those who have followed my reminiscences that have been published from time that I should reply to these inquiries, many of which, no doubt, have come in consequence of the reminiscences.

Back in the thirties a large portion of the work which, with my brother, Charles, we were doing in Philadelphia under the firm name of Coleman Sellers & Sons, was for the South. There was not a paper mill south of Mason & Dixon's line that we had not something to do with in the way of machinery; we also did much for the sugar and rice plantations, and the heavy work, such as gearing, for cotton and wool factories, including machine card clothing. This line of business brought me into close contact with many of the enterprising and progressive men of the South. Building the steam engines and most of the machinery for the mints of Charlottesville, Va., and Delonega, Ga., and putting them in motion, widened the circle of acquaintance and the surroundings, and I felt great interest in the progress the South was then making in the way of manufactures, and particularly in its iron and coal resources. This course of business necessitated frequent trips South, east of the Allegheny range, and made me well acquainted with that section of our country, but not with the far West and Southwest, until we removed to and settled in Cincinnati in 1841. Then my pursuits brought me into close contact with the master spirits of enterprise and progress in the Southwest, and opened the channels for becoming acquainted with its climate and resources.

I have now spent some hours with the help of a hand magnifying glass looking over old diaries with pencil entries for items and dates to refresh memory, but the research was so painful to my failing eyesight that I am compelled to give it up. Consequently, what I now have to say will be in a rambling way, trusting mainly to memory.

After making a preliminary survey for the then projected railroad from Covington to Lexington, Ky., on which survey my brother, Coleman, was one of the party, I was induced to make a personal reconnoissance in view of a railroad from Cincinnati to Charleston, S C. After the suspension work on the railroad from Knoxville, Tenn., to Dalton, Ga., to connect at that place with the Georgia State Railroad (then known as the Hiwasra Railroad, which was originally located and partly constructed by my esteemed friend, J. C. Trautwine), on the reorganization of this road as the East Tennessee & Georgia, General Duff Green took the contract for its completion, and my elder brother, Charles, went with him to Dalton as mechanical engineer. As near as I can recollect, it was in the spring of 1850 that I had an appointment to meet General Green at Dalton, of which I took advantage to visit my brother. The trip was made from Cincinnati to Louisville by mail steamboat, but from there the entire journey was by stage coach or mail wagon. When at Nashville, I met the chief engineer of the Nashville & Chattanooga Railroad, who accompanied me as far as to where the piers were being built for the bridge to cross the Tennessee River, now the town of Bridgeport. We crossed the river on a ferry scow, and made the rest of the distance to Chattanooga on the south side of the Tennessee River, crossing the north slope of Lookout Mountain. The computed distance from Nashville, by the route traveled, was 130 miles, and my memorandum made at the time, shows that we had been 42 hours in a United States mail conveyance, a fraction less than three miles per hour. Such was traveling in the South at that time!

I must here be permitted a digression. Some time previous (it was soon after the Cherokee Indians had been removed to their present territory), I chanced to travel by steamboat from Cincinnati to Wheeling, and from there by stage to Cumberland, and thence to Washington by rail, with John Ross, chief of the Cherokee nation, and his half brother, Lewis, and several full-blood Indians. John Ross was a native of Pennsylvania, having no Indian blood in his veins; Lewis was a half-breed. I had considerable conversation with them. John Ross was enthusiastic as to the beauties and healthfulness of their old home on the Tennessee River, particularly the Mission Ridge range, and the Cumberland plateau on Waldon's Ridge, as being entirely free from malaria and all pulmonary complaints. At that time I was suffering with hay fever, which malady had troubled me as far back as the time when the spring attacks were known as "rose colds," and those of the fall as "harvest asthma," neither of which I escaped. I casually remarked that in the fall attacks the pollen from the ragweed was a great aggravation. Ross laughingly

said that he could not conceive why the botanists had given the name "Ambrosia, food of the gods,"* to that worthless weed, and that to his mind the Cherokee name was more appropriate. I cannot recall the name he gave, but he explained it to mean "Sneeze-weed," and said that when the great ragweed of the river bottomlands was in pollen, they deserted their fishing stations. He thought I would find freedom from the worst symptoms on the Cumberland plateaus, as very little of the plant grew there, and what did was less aggravating; he thought its pollen was not at all irritating.

I had long cherished a hope that it would be with me as I had observed it to be with others who suffered from annual attacks of hay fever, that as I grew older the attacks would lessen in severity, but in Southern Illinois I found that was not the case, for the asthmatic stage of the complaint increased, and finally got so bad that for weeks at a time I was not able to lie down and take my natural sleep. I attributed this mainly to the increased growth of the ragweed in that section, owing to the fact that ground which for many years had been under cultivation for corn was now planted with wheat, and after harvest the fields of wheat stubble were covered by a thick growth of the worst variety of that pestiferous weed. If change of location was not a matter of life or death, it was at least a move to avoid or lessen great suffering, and I selected this section of country for the reasons I have stated, and with happy results.

I secured a favorable location on this historic ground, the crest of Missionary Ridge, close to where Gen. Braxton Bragg, had his headquarters at the time of the memorable battle of November 25, 1862, as a home for the remainder of my life. It is a quiet country location, with, for my family, all the city advantages of quick transit by the Union Railroad from Ridgedale, only a ten-minutes' down-hill walk, to say nothing of the time taken in climbing on the return. At the time I settled here there was a branch from the Union Railroad that climbed the hill, and then terminated on the Ridge, about 300 yards to the north, and was promised to be continued past my house, but it proved a failure, and finally fell into the hands of the Electric Street Railroad Co., who reconstructed and continued it southward as a crest road, the show road of the Ridge, and we now have from our door, direct communication with the heart of the city. At the time of my purchase, the Chickamauga National Park was only projected and had not taken form, but I have lived to see it realized, as well as the completion of the grand ridge boulevard, connecting the park with all the memorable points on the Ridge, including the Sherman earthworks on its northern extremity.

The story of the making of our new home, and of my accident, which so interfered with my intended work in this place, so rich in traces of the mechanic arts among prehistoric races, has been published at length in the reminiscences which appeared in the AMERICAN MACHINIST, July 23, 1891.

A more restful place for a weary mind cannot be found than my chair at the writing table in my den; it faces the bay-windows out of which I look to the east over ranges of hills and valleys until the view is bounded by the Great Unaka, or Smoking Mountains of Carolina; the window at my right sweeps the battlefield of Chickamauga to the mountain knobs of Georgia, and through the window at my left lies the Cumberland Range. Step to the west end of my den and the valley of Chattanooga is below, with the city and suburbs, and glimpses of the winding Tennessee River, Lookout Mountain, and Waldon's Ridge with the famous signal station. Ridgedale lies at the foot of the west slope of the ridge, and some of the houses and grounds extend nearly half way up. Among these is the house of Mr. Charles Edgar Paddock, whose father, Charles H. Paddock, now resides with him, and although he has passed the age for active work, being in the eighties, he still retains sufficient physical force to enable him, in favorable weather, to while away his time in cultivating a garden. As his power of locomotion has not deserted him, he has the advantage over me, and he frequently climbs the hill and spends hours with me in my den, comparing notes as to our early recollections of mechanical experience, and the various expedients that had to be resorted to for the accomplishment of certain objects. My acquaintance with Mr. Paddock dates back to 1841. He was at that time associated with Jeffrey Seymour who was then head of the Cincinnati Fire Department, and had charge of the city shops at the time of the first Cincinnati experiments with the steam fire engine, some account of which I have given in my reminiscences as published in the AMERICAN MACHINIST under dates of December 19, 1890, and January 2, 9 and 23, 1891. Mr. Paddock was one of the best of the old school mechanics, when to be a good workman a man must be master of many branches, and be able to skillfully handle every kind of mechanical tool, for both wood and metal working. Mr. Paddock has turned steam engine piston rods with hook and button-ended hand tools, with a correct eye, a straight-edge and calipers as his only guides.

When Shields built his 8-inch stroke, high-pressure engine for the Cincinnati Water Works, with double valve faces of 14"x21" for slide valves, perfectly faced and out of wind, it was with cold chisel and file that Mr. Paddock did the job, as well as the dressing and filing of the valves, all evidence of his standing as a workman. There was no planer in Cincinnati at that date.

These frequent discussions between Mr. Paddock and I often recall to memory circumstances in connection with machinery and labor-saving appliances that otherwise would be forgotten.

We take up the AMERICAN MACHINIST, and find every page replete with new designs or improvements on old ones, besides fully eight pages of illustrated advertisements of machine tool makers, showing their devices for doing every conceivable kind of work that can possibly be required in any construction of this advanced time. Contrast this with the rude and imperfect tools of the early machinist, and what he accomplished seems marvelous. Up to the time of my removal to Cincinnati, all the hand-turning lathes there had wooden shears, and engine lathes with cast-iron bed plates had these plates in short sections bolted to wooden shears, all hand finished by hammer, cold chisel and file. If longer work was called for the wooden lathe shears would be spliced, or if greater diameter was required than the hight of these centers rendered possible, the heads would be raised on wooden blocks to the desired hight.

The year 1840, I think, may be assumed as the period when improved machine tools became a necessity, and competition for business caused a rivalry that started a tide in that direction. There were several firms carrying on foundry and mill work in Cincinnati. Yeatman & Shields and Anthony Harkness had the largest portion of the work from the river steamboats, blowing cylinders and engines for blast furnaces, and they did considerable work for the Louisiana sugar planters; but in that line, notwithstanding that all the works were competing, Hanks & Niles were the most successful, for Jonathan Niles realized the value of effective tools, and for the heavy rolls and their shafting for sugar mills, he got up several substantial, heavy and effective lathes, and his horizontal facing and boring machine, which is a type of machinery still much used. The Powells, Renolds & Kite and Holliberd did a small share of the Louisiana work, but more of mill work than for the sugar planters. If my recollection is not entirely at fault, Geo. Shields was the first to get a planer in operation in Cincinnati. Harkness, as they say in the West, must "go him one better." He got a planer with which he could face the seats for the side pipes of the largest boat engine, and also take on its table the largest size of blowing cylinders then being made. I think the clearance between the uprights of his planer and below cross girt was about 6 feet square. This machine was designed and constructed by Alec. Latta, who was at that time foreman of Harkness' shops. To erect this large machine, an addition to the machine shop was necessary. This fronted on the street, which the end of the planer faced, leaving a passageway of about 3 feet between it and the brick wall, with a large window to light the wall, and to give passers-by a chance to see the machine at work, of which privilege crowds availed themselves as long as the novelty lasted. It certainly worked to perfection until an unfortunate accident occurred. The shifting gear to reverse the planer table failed to act; the heavy table with a steamboat cylinder on it shot across the passageway, carrying the brick wall and window into the street, and landing on the sidewalk. When Harkness saw the wreck he directed the cleaning up, simply remarking: "This is labor-saving with a vengeance." Although it was his first effort at labor-saving machinery, this mishap did not deter him from adopting new machines and new methods.

In one of these retrospective chats with Mr. Paddock, he gave me a graphic account of the expedients resorted to in boring the long-stroke cylinders for the river steamboats before cylinder boring machines were made, and I was surprised to learn that as late as 1838 the boring head was a fixture about central in the carrying shaft or mandrel, requiring a lathe bed twice the length of the cylinder to be bored. At this time, in the Eastern States, the splined boring bar with screw feed and sliding boring head had long been in use. Mr. Paddock spoke of the anxiety and responsibility of the workmen intrusted with the job; the care to be taken to have the casting thoroughly cleaned, any lumps chipped off that would be too hard on the cutting tools, and the workman having to forge, temper and grind his own tools. Great care was required in adjusting the two roughing tools on opposite sides of the boring head, the two finishing tools to follow the roughing tools dividing the head into quarters, and in the intervening slots of the boring head, blocks of hard wood were placed for steadiness; care too was needed to adjust the cylinder on the lathe carriages precisely central to the boring bar, for the cut when once started must go through. The workman had to bear in mind David Crockett's adage, "Be sure you are right, then go ahead."

This talk with Mr. Paddock brought to mind the primitive way in which the brass cylinders for the fire engines built by Sellers & Pennock were bored by manual labor as far back as 1817. I was so young at the time that my memory will not serve to reconstruct the apparatus in all its detail, but I can recall the general arrangement. The boring was done in the attic over their store and office in which no other work was done. A small wooden bench was used with an iron plate top, with a hole in its center about 2 inches diameter; besides numerous other holes being provided to be used with holding down bolts and for chips to fall through. The top of this bench was about as high above the floor as the length of the cylinder to be bored, or as I remember, about 14 inches, but on one occasion there was a hole bored in the floor to let the boring bar go down between the joists. The cylinder to be bored was placed on end central with the guide hole, the upper end of the boring bar passing through a wooden split box on a wooden hanger from the collar beam, high enough above the floor for a bareheaded man to pass under the support. A boring head was keyed to the boring bar. The cutters were keyed in slots in the boring head with wooden blocks in other slots to steady the cut, precisely as in the case mentioned by Mr. Paddock. Crossed handspikes or push bars were keyed to the boring bar. Four men might have been accommodated, but I do not remember that there were more than one or two men at work, for the cuts were light. To the upper end of the boring bar was swiveled a feed screw with a hand wheel to regulate it, and I was a very proud boy when perched up and permitted to operate the feed as directed from below. This feed screw was really a hold-back screw, for if not held back, the weight of the rod, boring head and handles would force the head down and jam. There was great resistance on the part of the old workmen to being harnessed into the jack mill, as their fellow-workmen guyed them as "mulies." Close by, however, there was a porter's stand of hand-carts and wheelbarrows, and these pushers were always glad of the job at the rate of a levy (York shilling) an hour or portion of an hour.

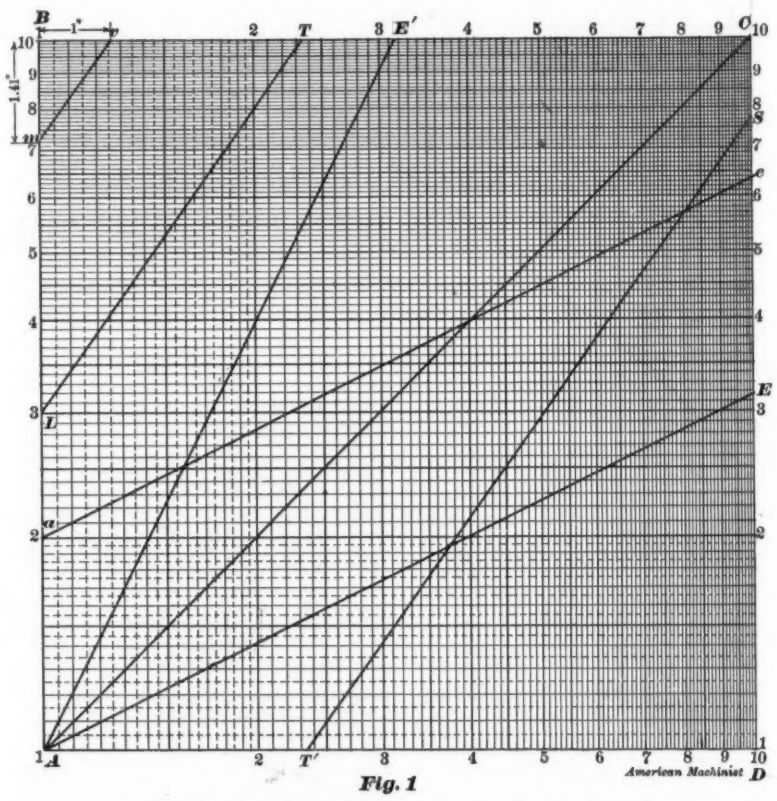


Fig. 1

ADIABATIC CURVE CONSTRUCTION.—SEE PAGE 611.

Charles Sheffield Mory, late chief engineer in the Chilian Navy, died recently in Brooklyn, N. Y. He was born in Cornwall, N. Y., in 1828, was on the Collins' line of steamers, and later went to Chili as engineer of a steamer built in the United States, served in the war against Spain, and later against Peru. After that he did constructive engineering work in Brazil.

*Ambrosia. Joseph Pitton de Fournefort. Generic name given to the ragweed. Roman wormwood; Hegweed; Bitter Weed.

A. trifida (Great Ragweed) moist river banks. Common.

A. bidentata; Michaux. Ill., Mo. & Southward.

Ambrosia is the Greek, and later Latin, name of several plants besides; the name given to "the food of the gods."

COLEMAN SELLERS.—ED.

Adiabatic Curve Construction—Uses of Logarithmic Section Paper.

In a recent contribution I ventured to express the opinion that the fullest advantage was not by any means taken of the graphic methods of calculating. Mr. Goodenough's article on "The Adiabatic for Perfect Gases," which appeared in your issue for June 13th, seems to fully confirm me in this opinion, as the appalling amount of work which the method there given entails, may be altogether dispensed with by the aid of a useful device which does not seem to be as widely known or as fully appreciated as it deserves to be. I refer to logarithmic section paper, to the advantages of which Mr. W. F. Durand, of Cornell University, has redirected attention during the last few years.

Reference to the accompanying diagram, Fig. 1, will render any extended description of this paper quite unnecessary. It may, however, be mentioned that as both the ordinates and abscissæ are located in precisely the same order as the divisions of the ordinary slide rule—it becomes an easy matter for anyone to construct such a section sheet, although in view of the fact that the paper may be readily procured from dealers in drawing materials and mathematical instruments—this course will seldom be necessary unless the size of the printed sheets (10″x10″ or 20″x20″) is unsuitable.

Users of the slide rule will readily perceive many of the uses to which such paper may be put, but its more important applications are not quite so apparent. However, for my present purpose, it will be sufficient to point out that if a line $A\ C$ be drawn from corner to corner of the square $A\ B\ C\ D$, then any ordinate will meet the similarly figured abscissa on $A\ C$. In other words, if we select any division on $A\ D$, follow its ordinate until it meets $A\ C$, and refer it horizontally to the scale $A\ B$, we shall find a similarly figured division to that initially selected on $A\ D$. If, however, we connect A with the middle point of $D\ C$, by the line $A\ E$, and use the latter as a line of reference, we shall find by proceeding in the same manner as before, that the result read off on $A\ B$ will be the square root of the initially selected value on $A\ D$. Thus the ordinate 9 followed up to $A\ E$, and referred to $A\ B$, gives 3 as $\sqrt{9}$, and so on. The reason of this is plain. The ordinates represent by their distance from the point of origin, A, the logarithms of the numbers by which they are distinguished. Further, the length of $A\ D$ being considered as unity, it follows that by referring the points of intersection of the ordinates with $A\ E$ to a scale whose length is .5, that the spaces representing the logarithms in $A\ D$ have been reduced in the proportion of 2 to 1. Thus the space length $A\ 9$ on $A\ D$ representing log. 9 (and corresponding to .954 of the absolute length of $A\ D$) has been reduced to $A\ 3$ on $A\ B$ (corresponding to .477 of the absolute length of $A\ B$) and representing log. 3, giving—since numbers and not logs are used—the value 3 as the square root of 9. A little consideration will show that the nth root of any number N may be readily obtained by drawing a line from A inclined at an angle, the tangent of which is n. Conversely, of course, nth powers may be quite as easily found, either by reading the numbers N on $A\ B$ and powers on $A\ D$, or by drawing other lines as $A\ E$, and reading as before.

One other point must be referred to before proceeding to apply the method to the particular purpose in view. In the previous cases the inclined lines such as $A\ E$ have been drawn from the point of origin A, but by shifting the line vertically upwards on the diagram through the space $A\ a$ for example, and using $a\ e$ as a reference line, it will be seen that to each of the readings formerly obtained on $A\ B$, and which previously represented log. $\sqrt{N}$ — a length = log. $A\ a$ has been added. Thus the product in this case is log. $A\ a + \frac{\log.\ N}{2}$. Thus results may be read off on $a\ B$ which give the product of $P\sqrt[n]{N}$, in which P is the number on $A\ B$ from which the inclined line is drawn, N, the value selected on $A\ D$, and n the tangent of the angle of inclination of the reference line, as previously explained.

It will be understood that the foregoing explanation is given in order to give some indication of one of the uses of logarithmic section paper. It is not necessary to understand the principle involved in order to use the device for the delineation of such curves as Mr. Goodenough refers to, but as this system of calculation is capable of a much more extensive application, I believe the explanation I have ventured to give will not be unacceptable to many. I readily admit that a more elegant method of description might easily have been devised, but I have endeavored to present the matter in as simple a manner as possible.

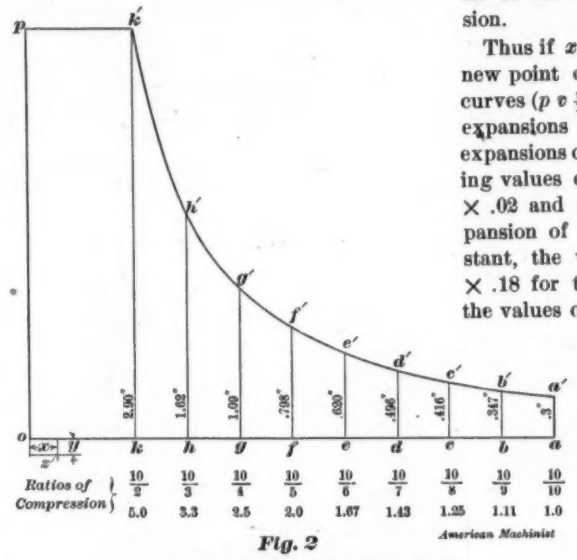


Fig. 2

ADIABATIC CURVE CONSTRUCTION.

We will now proceed to find a series of points in the adiabatic curve for perfect gases as required by Mr. Goodenough in the issue for June 13th.

Taking the data as given by your contributor we have Fig. 2) $a'\ a = .3$ inch, and $n = 1.41$, and it is required to find the hights of the several ordinates as $b\ b'\ c\ c'$, etc., which as now shown represent the pressure at successive eighths of the *compression period* of the stroke.

From the point $L\ (= .3)$ on $A\ B$ (Fig. 1) draw a line $L\ T$, such that $B\ T : B\ L : : 1 : 1.41$. This may be done by laying off from B, $B\ v = 1$ inch, and from the same point $B\ m = 1.41$ inches. Join $m\ v$ and from L draw $L\ T$ parallel to $m\ v$. Finally on $A\ D$ lay off from A a length $A\ T' = B\ T$, and draw $T'\ S$ parallel to $L\ T$.

We have now all that is required to obtain the hights of any number of ordinates in the compression curve. Taking successive tenths of the stroke (Fig. 2) it is seen that the compression ratio at $b = \frac{10}{9} = 1.11$, while that at $c = \frac{10}{8} = 1.25$, etc. Therefore all that is necessary to obtain the hights of the corresponding ordinates is to take an ordinate 1.11 on $A\ D$ (Fig. 1), find its point of intersection with $L\ T$ and refer it horizontally to the scale $A\ B$, reading thereon the required hight = .347 inch. Similarly the ordinate 1.25 on $A\ D$ (Fig. 1) is found to meet $L\ T$ at a point which referred to $A\ B = .416$, and this, therefore, is the hight of $c\ c'$ in Fig. 2.

It is evident that any number of points in the curve may be very readily found in this manner. The construction of an adiabatic passing through R is even more readily accomplished, but probably sufficient has been said to render any further description unnecessary.

Another advantage which this method offers is that the value of n in the equation to curves of the form $p\ v^n$ = constant can be easily found by plotting on the logarithmic section paper the successive pressure ordinates on $A\ D$, and finding the intersections of these with their corresponding volumes on $A\ B$. A line drawn through these points will cut $B\ C$ and $A\ B$ in points whose distances from B are as 1 and n respectively.

It need scarcely be mentioned that the method finds some of its most useful applications in connection with the construction of the well-known curves $p\ v^{\frac{17}{16}}$ = constant, and $p\ v^{\frac{10}{9}}$ = constant. These are, of course, only particular cases of the class of curve under consideration, but as they are of greater interest to the steam engineer it may be well to recall a very approximate method of drawing these curves, which was proposed some years ago by Mr. McFarlane Gray. This consists in drawing an ordinary hyperbolic curve, but instead of adopting the point O (Fig. 2) as the origin, other points are selected according to the character of the curve and the degree of expansion.

Thus if x and y are the co-ordinates of the new point of origin z, then for saturation curves ($p\ v^{\frac{17}{16}}$ = constant) $x = o\ k \times .05$ for expansions of from 1 to 5 and $o\ k \times .09$ for expansions of from 6 to 20. The corresponding values of y for these two cases are $o\ P \times .02$ and $O\ P \times .006$. For adiabatic expansion of steam, in which $p\ v^{\frac{10}{9}}$ = constant, the values of x are $o\ k \times .1$ and $o\ k \times .18$ for the above ranges of expansion; the values of y are those given for the saturation curve. This approximate method will be found of service in some cases, but with logarithmic section paper available there is no reason for employing it, as the accurate delineation of the curve can be accomplished with less labor and considerably greater satisfaction. Either method, however, appears to me to be far preferable to that described by Mr. Goodenough, and which, by the way, is to be found fully described in *Zeitschrift des Vereines Deutscher Ingenieure* for 1885 (Vol. XXXI, p. 433.)

M. E.

Electricity on Railroads.

A paper dealing with the problem of the ultimate substitution of electricity for steam on railway lines, was read by Dr. Louis Duncan, of Baltimore, before the American Institute of Electrical Engineers at the recent annual meeting. Dr. Duncan said: "In order that it should pay a railroad to make a change in its motive power, the effect of the change must be either to increase the receipts, or decrease the expenses, by an amount equal to the interest on the cost of the change. There should theoretically be such a gain; practically the amount would be greater in order to justify the change, to take into account those elements not capable of exact calculation. There are two very distinct sides to the question of transportation—the passenger side and the freight side—and their requirements for good service are very different. First taking up the question of passenger travel, the receipts of a road are increased by running trains at short intervals and at high speeds, and this is a condition peculiarly favorable to electricity. On the other hand, in the freight traffic, the conditions of greatest economy are reached when trains of a maximum weight are hauled by a single locomotive. The tendency in late years has been in the direction of increasing the size of the locomotive, the capacity of the cars, and the length of the trains. These changes have necessitated more solid and expensive roadbeds, heavier rails, and general strengthening of bridges. The outlay has been enormous, but the decreased cost per ton mile for freight transportation has shown the wisdom of the change." Dr. Duncan further said that in considering the application of electricity to steam roads it is important to note that any departure from a uniform distribution of load along the line, such as is incident to freight traffic, will increase both the cost of equipment and the cost of operation, for the electrical power stations must be made adequate to manage at all times the greatest congestion of traffic that can by any possibility occur.

Dr. Duncan formulated his conclusions as follows: "(1.) The tendency of passenger transportation on the steam lines has been in the direction of the greatest electrical economy, while the tendency of the freight transportation has been in the direction of the least electrical economy. (2.) It will not pay any through line with considerable traffic having two tracks to equip their main tracks electrically. (3.) With four-track roads it will pay to equip all of the tracks electrically, unless a considerable portion of the business is through passenger traffic. (4.) It will pay all the larger roads either to equip a number of their branch lines electrically, or to control competing electric lines. (5.) In order to remain on a dividend-paying basis it is imperative that most of the two-track lines either build additional tracks or control the electric roads that parallel them. (6.) Believing that ultimately all of the traffic will be done by electricity, it is imperative that the managers of steam roads keep constantly in touch with electrical progress." Dr. Duncan's reason for concluding that an electrical equipment would pay on a four-track road when it would not on two lines of tracks is that more perfect classification of the freight and passenger traffic, both express and local, can be secured on the four tracks, allowing the electrical power stations for the different lines of tracks to be run to carry burdens more definitely calculable, and with consequent closer economy.

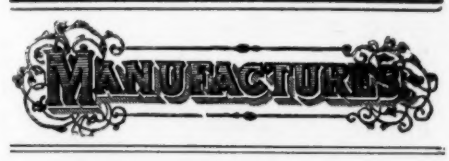
NEW CATALOGS.

There are three sizes of Standard Catalogs, 9″ × 12″, 6″ × 9″ and 4½″ × 6″. We recommend the 6″ × 9″ size for machinery catalogs. When they must be larger or smaller, one of the other standard sizes should be adopted if possible.

The Builders Iron Foundry, Providence, R. I., send us a pamphlet devoted to the illustration and description of wood polishing wheels manufactured by them. These wheels are made upon an improved plan, and are covered with heavy oak tanned leather for stock, and with any covering desired to special order. Standard wheels in great variety of sizes, widths, etc., are carried in stock. The pamphlet is 5½x8¾.

The Leland & Faulconer Mfg. Co., Detroit, Mich., issue a small pamphlet which is devoted to the illustration and description of their improved lathe center grinders, and in this way they have undertaken to do some needed educational work, respecting the proper method of centering work. There is also a treatment of the question of standard taper shanks for drills and similar tools, and it will be found of considerable interest to mechanics generally. The pamphlet is 3¾″x6″.

We have received from the B. F. Sturtevant Co., Boston, Mass., a catalog which is devoted to the subject of the ventilation and heating of school buildings. While this publication, we suppose, properly comes under the head of catalogs, it is also something of a treatise on the subject indicated, and is somewhat unique in character. We note that in the first twenty-five pages of this book the name of the Sturtevant Co. does not occur in the text, the general subject of heating and ventilation of school buildings being treated without reference to any special system. After that the particular system constructed by the above-named company is fully illustrated and described, with numerous examples of the latest practice. The book is uncommonly well gotten up as regards its mechanical features also, is elegantly printed on very fine paper, and bound in a unique style of leather binding. The pages are 7x9, the cover being somewhat larger. The first twenty-five pages of this book at least should be read by those shop proprietors and others interested in shops who have given the matter of scientific ventilation and heating little or no attention.



The Grand Rapids (Mich.) Wire Mat Co. has recently been organized with Frank C. Sayers as manager.

The Novelty Machine Works, of New Orleans, La., has been organized with W. H. Bofinger as president.

The Cleveland Cliffs Iron Mining Co., of Ishpeming, Mich., has increased the wages of all its employes 10 per cent.

The Southern Railway Co., of Atlanta, Ga., will shortly commence erecting its $300,000 machine shops at Atlanta, Ga.

The Horton Zinc Mining Co., of St. Louis, has been formed by Munroe Horton and Henry A. Johan with $60,000 capital.

The Peninsula Machine Co., of Grand Rapids, Mich., has been formed with a capital stock of $10,000. M. L. Fitch is president.

The American Pump Co., of Chicago, Ill., has been organized with a capital stock of $45,000 by C. C. Hill and R. F. Cummins.

The Southern Pine Co., of Savannah, Ga., has been incorporated by Henry Talmadge and James S. Tillmore with a capital of $1,250,000.

The Crown Mfg. Co., of New Bedford, Mass., makers of Crown bicycles, are making an addition to their plant, and will put in additional machine tools, especially milling machines and lathes.

The Warsaw Harrow & Mfg. Co., of Warsaw, N. Y., has been incorporated with a capital of $25,000, by Edwin A. Miller, Robt. D. Miller, John Brown and Elmer E. Bowe, of Warsaw, N. Y.

The Eagle Bicycle Co., of Torrington, Conn., now occupying premises owned by the Excelsior Needle Co., have purchased land and will erect their own buildings, which will be much larger than the present ones.

The Somersworth Machine Co., of Dover, N. H., have purchased from the Swamscot Machine Co. the patterns for all their horizontal boilers, and will be prepared to furnish repairs of the same from the original patterns.

J. H. Williams & Co., of Brooklyn, N. Y., has been organized to manufacture and sell machinery by James H. Williams, Wm. C. Redfield and Wm. J. Grinder, all of 9 Richards street, Brooklyn, N. Y. Its capital stock is $300,000.

A new cotton company has been organized at New Hope Mills, N. C., with a capital of $250,000. The officers of the company are Rufus Amis, of Virgilina, Va., president; Wm. Baker, of Blue Wing, N. C., vice-president, and R. T. Amis, of Virgilina, Va., secretary.

Mr. M. C. Henley, who was a successful roller-skate manufacturer, and has for some years past been building the Shellenback pulley lathe, has decided to go into bicycle manufacturing, and is fitting up a large and fine shop for the purpose in Richmond, Ind.

Mr. Rob't H. Casson, late of the rod department of the Rogers Locomotive and Machine Co., Paterson, N. J., has started a machine shop at 193 Liberty street, Paterson, N. J., where he will build special machinery and do jobbing of all kinds. He will make a specialty of finishing aluminum articles.

Mr. J. Hart Robinson, an electrician of 84 Pearl street, Brooklyn, N. Y., has devised a new form of battery, in which the plates are made porous in order to increase their effective surface. By this means several difficulties experienced with the ordinary storage battery are said to be overcome, and it is considerably lighter than other batteries of the same capacity.

The business carried on by John Adt & Son, New Haven, Conn., has, since the death of Mr. Adt, been purchased by Mr. F. B. Schuster, who was formerly with the Wilmot & Hobbs Mfg. Co. Mr. Schuster is an experienced designer and builder of tools, and in his new business will give his entire attention to such machines as have been made by the old firm, which include wire cutters and straighteners, riveting machines, foot presses, wire and sheet metal forming machinery, punches, dies, etc.

Machinists' Supplies and Iron.

New York, July 27, 1895.

Iron—American Pig—We quote standard Northern brands, $14 for No. 1; $13 for No. 2; $12.25 for No. 2 Plain, and $12 for Gray Forge. Southern brands, $13.50 to $14 for No. 1; $13 to $13.25 for No. 2; $12.50 to $12.75 for No. 3; $13 to $13.25 for No. 1 soft; $12.75 to $13 for No. 2 soft; and Foundry No. 4, $12.25 to $12.50

Antimony—A fair jobbing business has been done, and prices remain steady. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¾c. to 8½c; Hallett's, 7½c. to 7.35c.; U. S. French Star, 7.35c.; Japanese, 6.90c to 7c.

Lard Oil—Prime City we quote at 50c. to 51c.

Copper—The market is active and prices have advanced. Bids of 11¼c. for Lake Copper are scarcely considered, 11½c. seems to be the lowest price, and at this price sales have been made in a small way, but was refused for futures. For favored brands of Casting Copper 10⅝c. to 10¾c. is quoted.

Lead—The market shows signs of improvement, and prices are advancing, 3 40c. to 3.45c. is quoted for New York delivery.

Spelter—The market is firm, and a fair business has been done. The prices have advanced, 3.80c. to 3.85c. being quoted for New York delivery.

Tin—The market is active and prices are going up. Sales for prompt and near future deliveries have been made at 14.65c., and it is said that bids up to 14.75c. have been made.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS.

On and after July 4th this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted—Bright, active machinists to canvass for subscription to American Machinist, liberal commission. Address, with refs., Subscription Dep't, American Machinist, 203 Broadway, N. Y.

Young mechanical draftsman with experience, open for engag't; cert's.; refs. C. L. H., Am. Mach.

Mach.—Engineer wanted for Spanish country. Address Espanol, care of American Machinist.

(*Continued on Page* 613.)

Crescent Steel Co.

THE FINEST STEEL MADE.

Crescent Special

PITTSBURGH, PA.
CHICAGO, ILL.
NEW YORK, N. Y.

FOR DIES AND TOOLS DOING VERY HARD WORK.

SPEAKING of pumps, our catalogue is especially interesting, because it tells why the Mason Steam Pump **CAN'T HANG UP.**

THE MASON REGULATOR CO., Boston, U. S. A.

BUFFALO DRILLS.
For Blacksmith, Carriage & Wagon Manfrs. 24 Sizes.
Buffalo Forge Co. Buffalo, N.Y. U.S.A.

BUFFALO FORGES.
Americas Best. The World's Standard.
Buffalo Forge Co. Buffalo, N.Y. U.S.A.

BLOW YOUR CUPOLA
WITH A
"STURTEVANT BLOWER."
Send for Catalogues.
B. F. STURTEVANT CO.
BOSTON. NEW YORK. PHILADELPHIA. CHICAGO. LONDON, ENG.

CENTER GRINDERS,
WILLIAM BARKER & CO., Mfrs.,
IRON AND BRASS WORKING MACHINERY,
CINCINNATI, OHIO.

WILSON IMPROVED IRON PLANERS.
STANDARD SIZES KEPT IN STOCK. By W. A. WILSON, RIVER ST. ROCHESTER, N.Y.

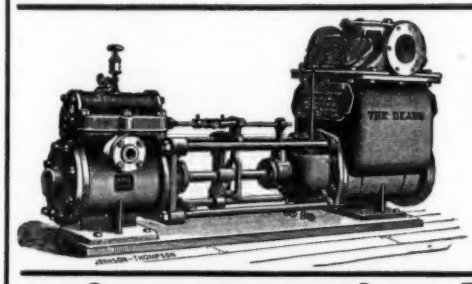
MARKING MACHINE,
For rolling trade-marks on flat or round Iron or Steel surfaces. Used by Cutlery, Pistol, Twist Drill, Wrench, and many other mfrs. 200 in use. Read up. Catalogue "B" free.
DWIGHT SLATE MACHINE CO.,
HARTFORD, CONN.

ARMSTRONG'S ✱ PIPE ✱ THREADING
—AND—
Cutting-off Machines

Both Hand and Power. Sizes 1 to 6 inches. Water, Gas, and Steam Fitters' Tools. Hinged Pipe Vises, Pipe Cutters. *Stocks and Dies universally acknowledged to be* THE BEST. ☞ *Send for catalog.*
Armstrong Mfg. Co., Bridgeport, Conn.

TECHNICAL EDUCATION.
The Bromfield-Pearson Technical School, of Tufts College, offers exceptional opportunities to students who wish to pursue a one or two-year course in engineering, or who may desire to fit for the engineering courses of the college in one year. Send for circular. Address,
GARDNER C. ANTHONY, Dean,
Tufts College, Mass.

BORING AND TURNING MILLS
ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.
We have a variety of sizes and a large stock for immediate shipment.
THE BULLARD MACHINE TOOL CO.,
E. P. BULLARD, Pres't. BRIDGEPORT, CONN.
New York Office, 86 LIBERTY STREET.

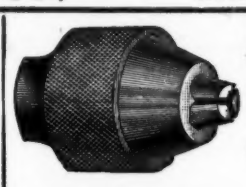


THE DEANE
OF HOLYOKE
VACUUM PUMPS,
DRY OR WET SYSTEM.
THE DEANE STEAM PUMP CO.,
HOLYOKE, MASS.
Send for "The Deane Specialties."

THE TAPS PASS CLEAR MAKING FULL
THROUGH THE NUTS FINISHED THREADS
THE GREEN RIVER SCREW PLATE
DIES ALWAYS READY TRUE TO SIZE
PERFECT SCREWS AT A SINGLE CUT

FINE SCREW PLATES.
"Lightning" and "Green River."
Taps, Dies, Reamers, Tap Wrenches, Bolt Cutters, Drilling Machines, Punching Presses and other labor saving Tools. Send for Catalogue.
WILEY & RUSSELL MFG. CO., - - Greenfield, Mass.

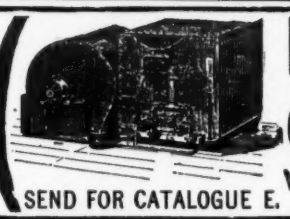
IT CUTS COSTS.
The McCanna Adj. Thread Cutting and Milling Tool.
Made only by
The Taylor-Rice Engineering Co., Wilmington, Del., U.S.A.



Almond Drill Chuck.
Sold at all Machinists' Supply Stores.
T. R. ALMOND,
83 & 85 Washington St.,
Brooklyn, N. Y.

SOFT CASTINGS,
Made from best grades of Pig Iron for Light Machinery, Electric Work, etc.
THE BURR & HOUSTON CO.,
33 TO 39 FRANKLIN ST., BROOKLYN, N. Y.

BLOCK CHAIN
for Chain Hoists, Pulley Blocks, Cranes, etc.
of any size and pitch, made to order at lowest prices. We invite correspondence.
SPEIDEL & ROEPER,
READING, PA.



HOT BLAST APPARATUS
VENTILATING, DRYING, HEATING.
GARDEN CITY FAN CO.
SEND FOR CATALOGUE E. MANUFACTURERS OF EXHAUST FANS, PRESSURE BLOWERS, ETC. CHICAGO, ILL. U.S.A.

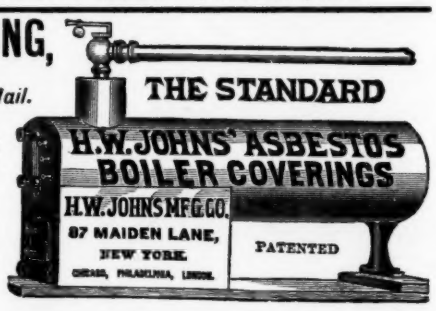
GRANT GEARS
Ready Made Iron Gears.
Ready Made Brass Gears.
Gears Made to Order.
Gear Cutting.
1895 Gear Book, Free.
Treatise on Gears, $1.00.
GEORGE B. GRANT,
Lexington, Mass.,
and 125 South 11th St.,
Philadelphia, Pa.,
and 86 Seneca St.,
Cleveland Ohio.

MECHANICAL DRAWING,
BY
C. W. MAC CORD.
4to, Cloth, - - - $4.00.
JOHN WILEY & SONS,
NEW YORK CITY.

"R. MUSHET'S SPECIAL STEEL"
SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
Sole Representatives in the United States.
B. M. JONES & CO.,
BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

LATHES! PLANERS!! SHAPERS, &c.!!!
Our tools are all of the latest and most approved designs, while the workmanship, material and finish are of the highest order. You will find it an advantage to have our catalogue and special prices before placing your order.
SEBASTIAN LATHE CO.,
117 and 119 CULVERT ST., CINCINNATI, OHIO.

ASBESTOS CEMENT FELTING,
FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.
87 Maiden Lane, NEW YORK.



Wanted—Two or three good machinists; machine hands preferred. Machinist, care AM. MACHINIST.

Wanted—Position as foreman machinist or in charge of power plant; 17 years' experience; good references. Box 60, AMERICAN MACHINIST.

Wanted—Position by a draftsman with technical education and experience in an engine building shop. W. M. C., AMERICAN MACHINIST.

Wanted—A situation by a first-class draftsman; A1 references furnished. Address Box 62, AMERICAN MACHINIST.

Man. training graduate, 3 years shop experience, wants position, shop or drafting. Address Lively, care of AMERICAN MACHINIST.

Mechanical draftsman with technical education, shop and office experience, wants position. Address Box 68, AMERICAN MACHINIST.

Sixteen years experience as draftsman, tool maker and foreman, wants situation on special machinery, investigate. Lock Box 160, De Kalb, Ill.

Wanted—One first-class patternmaker; good pay and steady work to satisfactory man. Address, with references, S. G. C., Box 927, Birmingham, Ala.

Superintendent open for engagement August 1st; well up in modern methods, machinery, tools, jigs, etc.; interchangeable work at minimum cost. Address Box 65, AMERICAN MACHINIST.

Wanted—Position by first-class engineer and machinist, charge of or erect power plant or other machinery; 12 years' experience; 5 years in large iron and steel works. J. P. C., AMERICAN MACHINIST.

Wanted—A good molder, capable of making water wheel castings and with ability and habits, to take charge of a shop. William Dolan & Co., Logansport, Ind.

Patternmaker and draftsman wants position, South preferred; large experience in agricultural machinery and special machinery for modern methods. Address Box 63, AMERICAN MACHINIST.

Mech. draftsman desires situation; exp. in machine tools and general machinery; good designer; shop exp.; capable of taking charge of drawing room; reference. Box 67, AMERICAN MACHINIST.

Wanted—Position as mechanical draftsman; technical education; experienced in drawing room and shop; willing to begin at bottom on high-grade machinery; good ref. Draftsman, AM. MACHINIST.

Position wanted as foreman master mechanic, or any capacity requiring the services of a first-class mechanic; experienced in marine and stationary engine building and rolling-mill work, and very good draftsman. Box 64, AMERICAN MACHINIST.

Wanted—A practical man with some capital, a knowledge of drawing and mining machinery, to take charge of a foundry and machine shop in a mining district. Address, giving references and experience to Box 70, AMERICAN MACHINIST.

Wanted—Position by a competent machinist and toolmaker, who understands modern methods and drafting, as foreman in machine shop, or chief toolmaker in large plant; best of references. P. F. S., 42 Cristel St., Chicago, Ill.

Responsible position desired by mechanical engineer, qualified by shop experience, theoretical knowledge, extensive engineering practice; well fitted for designing, estimating, corresponding, or representative engineer. Address "Mechanical," care P. Scott, 2823 North Robey St., Chicago, Ill.

Wanted—Position with manufacturing company as master mechanic or foreman of machine department; 20 years' experience in die work & the building of light automatic machinery for economically working sheet metal and wire; best of references. Box 69, AMERICAN MACHINIST.

A young man who is ambitious to work himself up, would like a position in a drawing room, where there is a chance for advancement. Have had 5 years shop experience, with 3 years at the drawing school of the Franklin Institute, Philadelphia. Address A., care AMERICAN MACHINIST.

✣ MISCELLANEOUS WANTS ✣

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

Pat's obt'd; no atty's fee until allowed; exp't service. Thurman & Silvius, mech. engs., Ind'polis, Ind.

Wanted—Second-hand lathes, planers, shapers, drills, screw machines, milling machines, and boiler tools, etc. Address Box 51, AM. MACHINIST.

Wanted—To correspond with any one in need of a first-class key-seater, Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

For sale—Modern, fully-equipped emery wheel plant; my reason for selling, other business interests. Address Emery, AMERICAN MACHINIST.

Wanted—Second-hand automatic gear cutters. Address giving condition, price, and how quick shipment can be made to Box 66, AMERICAN MACHINIST.

Introduction and negotiation of American patents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

For sale—Hydraulic press, 14 inches ram, made by John Robertson & Co., Brooklyn, has rapid motion attachment; is in first-class condition. For terms address Press, Box 826, Providence, R. I.

For Sale—An old established blacksmithing and manufacturing business with machinery, steam and drop hammers and tools, have made a staple article for years, could be made a good machine business. Enquire H. Pigg, Bridgeport, Conn.

Wanted—Patented or special articles to make of aluminum, brass or iron; facilities unexcelled; exceptionally low prices quoted on experimental or jobbing machine work; write for prices. Rob't H. Casson, works, 198 Liberty St., Paterson, N. J.

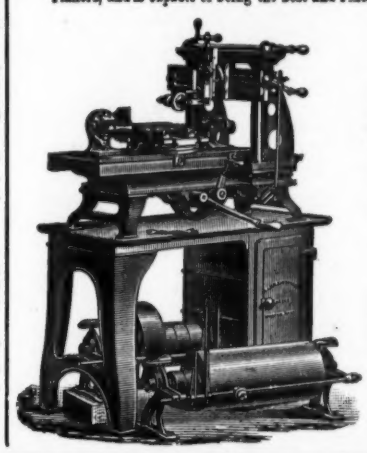
Wanted—An Idea. Who can think of some simple thing to patent? Protect your ideas; they may bring you wealth. Write John Wedderburn & Co., Patent Attorneys, Washington, D. C., for their $1,800 prize offer.

For sale—The entire outfit of a foundry and machine shop, together with an unexpired lease of the premises; the plant is situated in a prominent railroad center in the State of New York, and is now doing a thriving jobbing business, employing from 35 to 40 hands; reasons for selling, ill health of proprietor. Address "Iron Worker," care AMERICAN MACHINIST.

POWER OR HAND PLANER,

FOR MODEL MAKERS, EXPERIMENTAL WORK, &c.

Has all the Improved Features Usually Found on High Grade Planers, and is Capable of Doing the Best and Finest Work.



MANUFACTURED BY A. J. WILKINSON & CO., 184 Washington Street, Boston, Mass.

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON

NICHOLSON FILE CO.

PROVIDENCE, R. I., U. S. A.

3000 VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

REDUCED PRICES OF LeCOUNT'S STRAIGHT TAIL DOG.

To be driven from a Stud in the Face Plate.

No.	INCH.	PRICE.	No.	INCH.	PRICE.
1	¾	$0.60	10	2¼	$1.35
2	⅞	.70	11	2½	1.45
3	1	.70	12	3	1.60
4	1⅛	.80	13	3½	1.80
5	1¼	.80	14	4	2.10
6	1⅜	.95	15	4½	2.75
7	1½	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set.		31.10

These Goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.

C. W. LeCOUNT, South Norwalk, Conn.

THE BERLIN IRON BRIDGE CO.

Office and Works,

No. 8 Railroad Ave., East Berlin, Conn.

CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary

Engineers, Architects and Builders of

Iron and Steel Bridges and Buildings.

The above illustration taken direct from a photograph, shows the construction of a Machine Shop designed and built by us for the Link Belt Machinery Co., at Chicago, Ill. The building is 124 feet in width by 407 feet in length. Each side wing is 42 feet in width and two stories high. The central portion of the building is 50 feet in width controlled by a hydraulic crane with a travel the full length of the building. This is probably one of the best designed modern Machine Shops to be found in the United States.

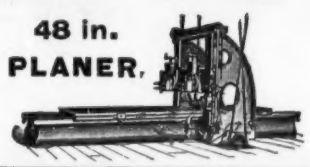
SEND FOR OUR ILLUSTRATED CATALOGUE.

PLANERS

AND OTHER METAL WORKING TOOLS.

FITCHBURG MACHINE WORKS,
FITCHBURG, MASS.
CATALOG E.

48 in. PLANER.



Star Foot-power Screw Cutting Lathes Automatic Cross Feed

9 and 12 inch Swing.

New Designs. Novel Features.
Send for Catalogue B.
SENECA FALLS MFG. COMPANY
687 Water St., Seneca Falls, N. Y.

STEAM CARRIAGE FOR SALE.

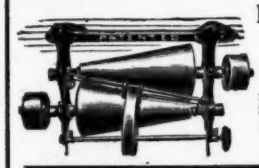
A practical road wagon, built by an engineer of known reputation. Price reasonable. Send for descriptive circular to

H. W., Box 1530, Boston, Mass.

ENGINEERS and FIREMEN Send for a 24-page pamphlet on how to pass an examination to procure an engineer's license.

C. G. KRELL, 3017 N. 13th St., ST. LOUIS, MO.

EVANS FRICTION CONE CO.



HANGING AND STANDING CONES.
MADE IN ALL SIZES.

Thousands in use transmitting from 1 to 50 H. P. For information address,

No. 85 WATER STREET, BOSTON, MASS.

IF YOU WANT ANYTHING IN THE LINE OF DROP PRESSES · DROP HAMMERS · STAMPS OR AUTOMATIC DROP LIFTERS.
SEND FOR CATALOGUE TO
Miner & Peck Mfg. Co.
NEW HAVEN, CONN.
LARGEST LINE IN THE MARKET

SEND FOR CATALOGUE.

WORCESTER MACHINE SCREW CO

Manufacturers of Set, Cap & Machine Screws, Studs, etc.

CORUNDUM WHEELS VS. EMERY WHEELS.

Once use a wheel made out of pure selected Corundum and you will want no other.

MASSACHUSETTS CORUNDUM WHEEL CO.,
Mfrs. of Rapid Cutting Corundum Wheels,
No. 424 Atlantic Ave., BOSTON, MASS., U. S. A.

P.H.&F.M. ROOTS,

Connersville, Indiana.

CHICAGO OFFICE:
1405-10 Manhattan Building.
MANUFACTURERS OF
Portable Forges,
Tuyere Irons, Etc.
ROOTS' NEW ACME HAND BLOWERS,

Slow speeded, Force blast, Durable, Compact and Cheap.

Roots' Foundry Blowers, Gas Exhausters, Etc.

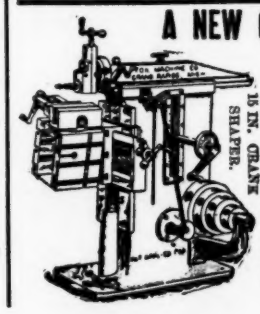
COOKE & CO.
Selling Agents,
163 and 165 Washington St.,
NEW YORK.

In Writing, Please Mention This Paper.

HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.

Our New and Revised Catalogue of Practical and Scientific Books, 88 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

A NEW CRANK SHAPER.



NOVEL, YET SIMPLE.

Length of stroke changed INSTANTANEOUSLY while IN MOTION.

Get Photos & Prices.

NOTHING LIKE IT.

Fox Machine Co.,
325 Nor. Front St.,
Grand Rapids, Mich.
135 Finsbury Pavement, London, England.

JESSOP'S STEEL

FOR TOOLS, DRILLS, DIES, &c.

ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.

NEW HAVEN, July 19th, 1895.

Messrs. HOUGHTON & RICHARDS, BOSTON, MASS.

Gentlemen:

In reply to your inquiry about what I think of the STYRIAN STEEL, I would say that I made Sub-Press Punches and Dies of it and did work where I could not get any other Steel to stand, and I think it is the best Steel in the world, and I have tried about all of them.

Yours truly,
(Signed) GEO. M. GRISWOLD.

This Steel was Extra Tough and Hard.

HOUGHTON & RICHARDS,
SOLE AMERICAN AGENTS,
148 & 150 OLIVER ST., BOSTON

WORTHINGTON PUMPING ENGINE

FOR WATER WORKS.

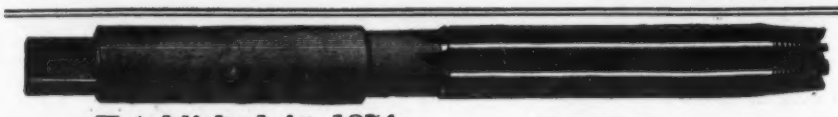
SIMPLE, COMPOUND, OR TRIPLE EXPANSION, HORIZONTAL OR VERTICAL

HIGHEST DUTY GUARANTEED.

COMPLETE DESCRIPTIVE PAMPHLETS ON APPLICATION.

HENRY R. WORTHINGTON,

NEW YORK, 86 and 88 Liberty St. BOSTON, 70 Kilby St. PHILADELPHIA, 607 Arch St. CLEVELAND, 24 South Water St. CHICAGO, 185 to 189 Van Buren St. ST. LOUIS, Eighth and St. Charles Sts. INDIANAPOLIS, 64 South Pennsylvania St.



Established in 1874.

CLEVELAND TWIST DRILL CO.

COR. LAKE & KIRTLAND STS. CLEVELAND, O.

99 Reade Street, New York.
85 Queen Victoria St., London, Eng.
5 Neue Promenade, Berlin, C., Germany.

NEW AND SECOND-HAND MACHINERY.

ENGINE LATHES.

13 in. x 6 ft. Blaisdell.
14 " x 6 " Flather.
15 " x 6 " Standard.
15 " x 8 " Standard.
16 " x 6 " Blaisdell.
16 " x 7 " Pratt & Whitney.
18 " x 8 " Fitchburg.
18 " x 8 " Flather.
20 " x 8 " Putnam.
20 " x 10 " Harrington.
24 " x 12 " New Haven.
24 " x 22 " Perkins
27 " x 12 " Heavy, Improved.
28 " x 16 " Fay & Scott.
32 " x 16 " Waterman.
72 " x 30 " Union.

DRILLS.

Sensitive Drills, Improved.
28 in. Back Geared, Blaisdell.
28 in. complete, Latest Pattern.
Radials, 3, 4 and 5 ft. Arms.

HOR. BORING & DRILLING MACHINES.

Sellers, 54 in. swing, complete.
Bement, 54 in. swing, No. 2.
Cyl. Borer 12 to 36 in. cyls.

PLANERS.

22 in. x 5 ft. Putnam.
22 " x 5 " Pease.
24 " x 5 " New Haven.
24 " x 6 " Lathe & Morse.
24 " x 6 " Rochester.
28 " x 5 " Gage.
30 " x 10 " Harrington.
48 " x10 " Gray, 2 Heads, A1.

SHAPERS.

8 in. Stroke, Crank Motion.
15 " " " "Gould & E.
16 " " " "Prentiss.
14 " " Trav. Head, with centers, circular feed, Fitchb'g.

SLOTTERS.

10 in. Stroke, Lowell.
18 " " Bement.

BOILER ROLLS.

7½, 8 and 10 ft. Good order.
8 and 10 ft. New Improved.

SCREW MACHINES.

P. & W. No. 2 Wire Feed.
Brown & Sharpe No. 5, complete.

MILLING MACHINES.

Garvin No. 3 Power Feed.
Lincoln Pattern with Vise.
"Universal" Latest, good as new.
P. & W. No. 2 Hand Feed, A1.

Gray Planers "NEW," 22, 24, 30 and 36 in.
Kempsmith Millers, Universal and Plain.
Bardons & Oliver's Screw Machines, Improved Style.
Fitchburg Lathes, 14 to 72 in. Swing.

J. J. McCABE,

SUCCESSOR TO E. P. BULLARD'S N. Y. Mach'y Warerooms.

14 Dey St., NEW YORK.

SECOND-HAND MACHINE TOOLS.

ENGINE LATHES.

12 in. x 5 ft. Ballou Patent.
16 in. x 6 ft Ames Mfg. Co.
16 in. x 8 ft. Perkins Taper.
18 in. x 10 ft. Blaisdell.
28 in. x 20 ft. Perkins.
37 in. x 14 ft. Maker Unknown.

PLANERS.

12 in. x 30 in. Wilkinson for Hand or Power.
22 in. x 22 in. x 4 ft. L. W. Pond.
24 in. x 24 in. x 5 ft. Putnam.
24 in. x 24 in. x 6 ft. Chamberlin.
24 in. x 24 in. x 5 ft. Whitcomb.

SHAPERS.

10 in. Pratt & Whitney.
12 in. Juengst, Crank.
15 in. Juengst Friction.
10 in. Wood and Light Traverse Head.
21 in. Smith & Silk, Shifting Belt.
20 in. Gould & Eberhardt.
24 in. Hendey, Friction.

DRILL PRESSES.

3 Spindle Woodward & Rogers.
6 Spindle Quint, Turret.

DRILL PRESSES.

No. 1 Two Spindle, Garvin.
No. 2 Three Spindle, Garvin.
No. 2 Four Spindle, Pratt & W.
No. 4 Four Spindle, Garvin.
20 in. Davis, Wheel Feed
24 in. Blaisdell Wheel Feed.
24 in. Aurora, Back Geared.
30 in. Pond, Back Geared, Power Feed.
9 ft. Holly Mfg. Co., Radial.

SCREW MACHINES.

No. 00 Garvin, Wire Feed.
No. 5 Brown & Sharpe.
2 No. 1 Brown & Sharpe, Wire Feed.
No. 2 Brown & Sharpe, Automatic.
No. 2½ Pratt & Whitney.
No. 2 Garvin, Plain.

MILLING MACHINES.

6 No. 2 Pratt & Whitney, Lincoln.
1 No. 20 Garvin, with arm.
2 No. 2 Garvin, Plain.
1 No. 0 Garvin Universal.
1 No. 1 Garvin Universal.
No. 2 Garvin Duplex.

Also, a large list of other machines. Write for complete list, detailed description and prices.

THE GARVIN MACHINE CO.,

LAIGHT & CANAL STS., NEW YORK.
Also, 51 North 7th St., Philadelphia, Pa.

SECOND-HAND MACHINERY.

Gould & Eberhardt Automatic Gear Cutter.
Pratt & Whitney 26" Chucking Lathe.
18"x5' Pratt & Whitney Lathe, taper attachment.
Niles Horizontal Boring Machine, 4" bar.
Betts Horizontal Boring Machine, 3" bar.
60" Triple Geared Engine Lathe, 1894 Pattern, used Three Months, a modern tool in fine order.

Will sell the above tools at low prices. Send for new catalogue of Bicycle Machinery.

PRENTISS TOOL & SUPPLY CO.,
62 & 64 So. Canal St., CHICAGO, ILL.

CALIPER SQUARES

Any Style or Graduation.
5 Sizes, Metric and Vernier System.
WARRANTED ACCURATE.
Send for Catalogue and Special Prices to
E. G. SMITH, Columbia, Pa.

MACHINERY FOR SALE.

28 in. x 24 in. x 7 ft. New Haven Planer. New.
21 in. Gould & Eberhardt Drill. Good as new.
6 in Boynton Hand Shaper. " " "
¾ to 1¼ in. Open-die Bolt Cutter " " "
Nos. 1, 5 and 6 Roots Pressure Blowers. A1 condition.
9 x 9 Greenfield Upright Engine. Good as new.
36 in. x 7½ ft. Upright Boiler. Good order.
Lot 6½ in. and 7½ in. Hammered Steel Shafting.
Bearings, Friction Clutch Pulleys, etc., less than half value.

COOKE & CO.,
163 and 165 Washington St., NEW YORK.

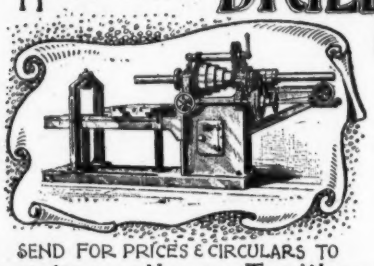
IN STOCK

CONOVER'S CONDENSERS

HANDSOME CATALOGUE ON

THE CONOVER MFG. CO. 39 CORTLANDT ST. N.Y.

Horizontal DRILLING AND BORING MACHINE



We build all sizes of these . . machines, and can . .

DELIVER PROMPTLY.

SEND FOR PRICES & CIRCULARS TO
THE NEWARK MACHINE TOOL WORKS. Newark, N.J.

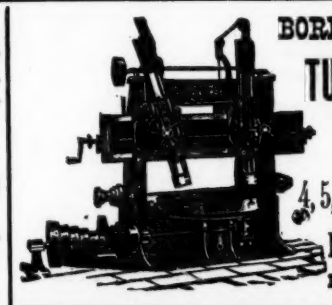
ROSE POLYTECHNIC INSTITUTE

Terre Haute, Ind. A School of Engineering. Mechanical, Electrical, Civil Engineering, Chemical courses. Well endowed. Extensive Shops and Foundry. Modernly equipped Laboratories in all departments. Expenses low. Address **C. L. MEES, President.**

BEVEL GEARS,

Cut Theoretically Correct.
Special facilities for cutting worm wheels.

HUGO BILGRAM,
MACHINIST,
440 N. 12th St., Philadelphia, Pa.



BORING AND TURNING MILLS,

4, 5, & 6 ft. Swing

H. Bickford,
LAKEPORT, N. H.

E. W. BLISS CO.

1 ADAMS ST., BROOKLYN, N. Y.
Chicago Office, 96 W. Washington Street.

FOOT AND POWER MACHINERY FOR WORKING SHEET METAL.

FORGING PRESSES, PUNCHES, SHEARS AND SPECIAL MACHINERY.

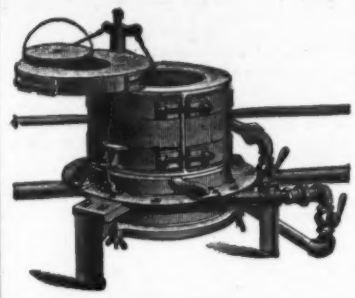
A NEW FRICTION CLUTCH.

STILES & PARKER PRESS CO.

COLD SWAGING MACHINE

The Dayton Swaging Machine is the best for reducing and pointing wire and tubing. If interested address the manufacturers,

EXCELSIOR NEEDLE CO.
Torrington, Conn.



AMERICAN GAS FURNACE CO.,

OIL GAS PLANTS

Gas Blast Furnaces & High Pressure Blowers

For the economical generation and systematic application of HEAT.

CATALOGUES ON APPLICATION.

No. 80 Nassau Street, - - NEW YORK.

ENGLISH AGENCY:
Chas. Churchill & Co., Ltd., 21 Cross Street, Finsbury London, E. C., England.

Immediate Shipment

can be made of any of the following high grade machine tools, viz:

Lathes 12", 14", 15", 16",

MADE BY

FLATHER & CO.,
PRENTICE BROS.,
P. BLAISDELL & CO.,
DRAPER MACHINE TOOL CO.

ALSO

Screw Machines,
Turret Machines,
Milling Machines
and Upright Drills.

HILL, CLARKE & CO.,

156 Oliver St., BOSTON.
12 & 14 S. Canal St., CHICAGO, Ill.

NOTE.—We are making a specialty of complete outfits for bicycle works.

Second-Hand Machinery.

1 48 x 36 in. x 10 ft. Pond Machine Tool Co. Planer, 2 heads.
3 48 x 32 in. x 6 " " " " 2 "
1 48 x 32 " x 8 ft. " " " " 2 "
1 42 x 42 in. x 2 ft. " " " " 2 "
2 60 x 60 " x 22 ft., 2 heads.
1 12 x 10 Niles Lathe, Taper Attach.
1 22 x 9 P. & W. " "
1 24 x 10 Perkins Lathe.
3 18 x 6 Lodge & Davis, Taper Attach.
1 79 in. Bement Driving Wheel Lathe.
1 90 x 16 Swamscott Lathe.
1 32 x 10 Open Side Planer.
1 15 in. Pratt & Whitney Shaper.
1 No. 2 Brown & Sharpe Universal Grinder.
1 No 2 " " Surface Grinder.
1 No. 15 Garvin Miller.
1 No. 4 Cincinnati Universal Miller.
1 18 in P. & W. Turret Head Chucking Machine.
2 No. 2 Bement Horizontal Boring and Drilling Machine.
2 No. 2 Niles " " " " "
1 No. 2 Pedrick & Ayer Cylinder Borer.
2 No. 1½ Niles Radial Drills.
1 30 in. Motor Gear Lathe, Lodge & Shipley.
1 10 in. Niles Slotter.

Also large stock of other tools. Send for List.

Eastern Branch Niles Tool Works Co.,
136 and 138 Liberty St., NEW YORK CITY.

MACHINERY BARGAINS

BEFORE REMOVAL

At Phœnix Iron Works, Trenton, N. J.

15 in. x 6	ft.	Engine	Lathe.	52 in. x 20 ft.	Engine Lathe.
22 " 12	"	"	"	19-36 and 50 in.	Drills.
29 " 13½	"	"	"	Portable	Drill.
26 " 20	"	"	"	36 in. x 14 ft.	Planer.
19 " 12	"	"	"	12 in. Shaper	Traverse Head.
37 " 30	"	"	"	Gear Cutter,	54 in.
71 " 18	"	"	"	Milling	Machine.

10 ft.-16 ft. Vertical Boring and Turning Mill, Cranes, Blower, Boiler Rolls, Punch and Shear, etc.

Send for full list and prices.

GEORGE PLACE MACHINE CO.
145 Broadway and 86 Liberty St.,
NEW YORK.

CHARLES H. BESLY & CO., CHICAGO ILL., U. S. A.
FINE TOOLS FOR METAL WORKERS, FILES, DRILLS CHUCKS, PLYERS, NIPPERS, STEEL RULES, SCALES, EMERY, EMERY WHEELS, OIL STONES, EMERY PAPER.
EMERY CLOTH, SHEET BRASS, BRASS WIRE, BRASS TUBES, COPPER TUBES, SHEET COPPER CALIPERS, ALUMINUM, HELMET SPRING BRONZE, GERMAN SILVER, NICKEL ANODES, MICROMETERS.

MACHINE TOOLS.

IN FIRST-CLASS CONDITION.

16 in. F. B. Miles Slotting Machine.
2,400 Pound Miles Steam Hammer, Single Standard.
30 in. by 27 ft. Pratt & Whitney Engine Lathe.
Horizontal or Floor Boring Machine, Pratt & Whitney.
Two (2) 5 ft. Universal Radial Drills.
21 in. x 11 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
19 in. x 8 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
26 in. x 8 ft. Pond Machine Tool Co. Engine Lathe.
19 in. x 12 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
22 in. x 12 ft. Pratt & Whitney Engine Lathe, Hollow Spindle
21 in. x 11 ft. Lodge & Davis Engine Lathe, Hollow Spindle and Taper Attachment.
40 in. Bement Vertical Drilling Machine.
24 in. Pratt & Whitney Vertical Drilling Machine.

GEORGE PLACE MACHINE CO.,

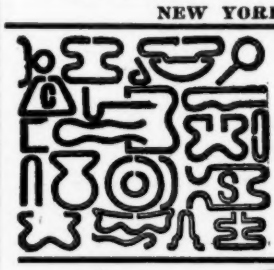
146 Broadway & 86 Liberty St., New York.

Stover Power Hack Saw and Friction Drills.

Saws made in two sizes Nos. 1 and 2. Cut 4½ to 8 inches. Send for circulars to

STOVER NOVELTY WORKS

Mfgrs. of Wood and Iron-Working Machinery
Special Machinery to order.
23 River St., FREEPORT, ILL., U. S. A.
C. W. BURTON, London, Eng.



BLAKE & JOHNSON, Waterbury, Conn.

BUILDERS OF

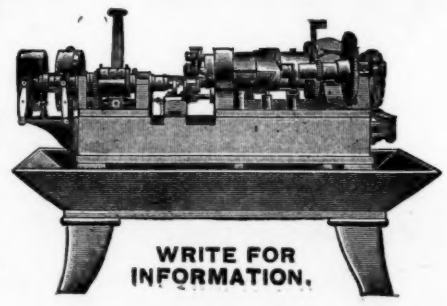
PIN, SAFETY PIN, HOOK AND EYE MACHINERY,

AND LABOR-SAVING MACHINES OF EVERY DESCRIPTION.

Bent Wire Goods a Specialty. Send Samples that we may quote prices for either machine or the Goods.

STEEL BALLS

For all Anti-Friction Purposes.



WE ALSO MANUFACTURE

AUTOMATIC SCREW MACHINES

AND

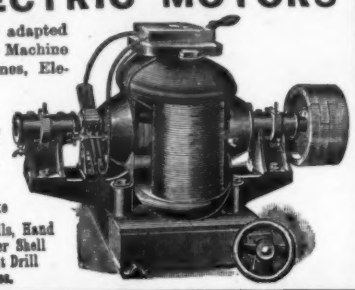
SCREW MACHINE PRODUCT

OF EVERY DESCRIPTION.

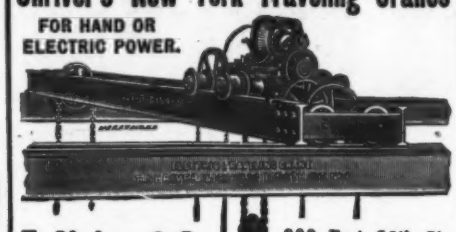
Cleveland Machine Screw Co.,
CLEVELAND, OHIO.

WRITE FOR INFORMATION.

THOS. H. DALLETT & CO.,
YORK ST. & SEDGLEY AVE., PHILADELPHIA.
MANUFACTURERS OF
ELECTRIC MOTORS
Specially adapted for driving Machine Tools, Cranes, Elevators, Pumps, Presses, and other Machinery.
We also make Portable Drills, Hand Drills, Boiler Shell Drills, Light Drill Presses.

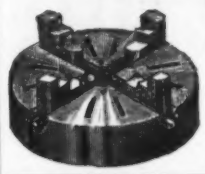


Shriver's New York Traveling Cranes
FOR HAND OR ELECTRIC POWER.



T. Shriver & Co. 333 East 56th St., NEW YORK.
MANUFACTURERS OF
TRAVELING CRANES of 1½, 2, 3, 5 and 10 Tons capacity, to be operated by Hand, or wholly or in part by Electricity.

WHEN YOU ORDER
HORTON CHUCKS,
See to it that our TRADE MARK
"THE HORTON LATHE CHUCK"
Is stamped plainly on their face, all others are IMITATIONS.

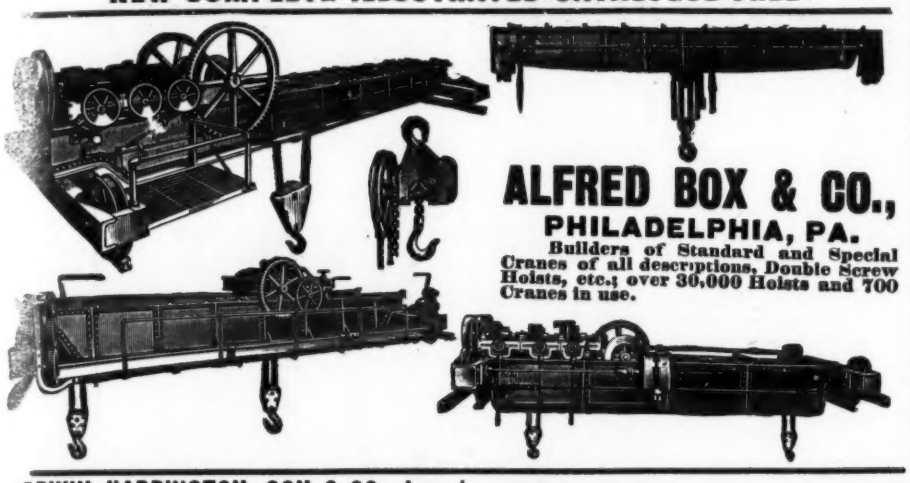


THE E. HORTON & SON CO.,
WINDSOR LOCKS, CONN., U. S. A.
Or CHAS. CHURCHILL & CO., 21 Cross St., Finsbury, London, E. C., Eng.

"CUSHMAN" CHUCKS.
For Lathes, Drills, Chucking and Screw Machines, and for Special work. . . . . .
SEND FOR CATALOGUE.
THE CUSHMAN CHUCK CO., HARTFORD, CONN.

EMERY WHEELS NORTON Emery Wheel Co. Worcester, Mass.

NEW COMPLETE ILLUSTRATED CATALOGUE FREE.

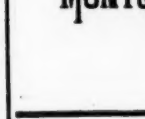


ALFRED BOX & CO.,
PHILADELPHIA, PA.
Builders of Standard and Special Cranes of all descriptions, Double Screw Hoists, etc.; over 30,000 Hoists and 700 Cranes in use.

FOR PLANER CHUCKS
Address G. W. JORDAN,
4 WAYNE STREET, WORCESTER, MASS.

PEQUOT DRILL CHUCK.
A new Drill Chuck having a more powerful grip than any chuck ever offered. This seems a broad claim, but we prove it to mechanics who will examine. Ask at your dealers or write us for particulars.
THE D. E. WHITON MACHINE CO.,
5 Oak Street, New London, Conn., U. S. A.,
OR, SELIG, SONNENTHAL & CO.,
85 Queen Victoria St., London, E. C., England.

CHUCKS The "National."
INDEPENDENT, UNIVERSAL, or COMBINATION.



Est'd 1882. Strongest. Easiest to change. Best finish. Reversible Jaws (patented) giving 5 changes including every possible position. ILLUSTRATED CATALOGUE sent. Liberal discounts. Prompt shipment. W. WHITLOCK, 39 Cortlandt St., N. Y.—Works, Hoboken, N.J. McDowell Stocker & Co., Chicago.

SKINNER CHUCKS.

Independent and Universal Chucks, Combination Lathe Chucks with patent reversible jaws, Drill Chucks, Planer Chucks and Face Plate Jaws.
SKINNER CHUCK CO.,
New Britain, - - Conn.
SEND FOR CATALOGUE.

WE LEAD, OTHERS FOLLOW.
Sweetland Combination Chuck.

Reversible Jaws. Accurate, Standard Independent, Solid Shell, Solid Reversible Jaws, Strong and True.
SEND FOR CATALOGUE.
The HOGGSON & PETTIS MFG. CO., - New Haven, Conn.

PRATT'S Positive Driving Drill Chuck.

The best system ever devised for holding and driving drills.
WRITE FOR CATALOGUE TO
THE PRATT CHUCK CO., Clayville, N. Y.

EDWIN HARRINGTON, SON & CO., Inc.,
1515 Penna Ave., Phila., Pa.,

Extension Lathes, Drill Presses,
Traveling Cranes, Chain Hoists.

Cranes
AIR HOISTS, CUPOLAS, Etc.,
Whiting Foundry Equipment Co.,
Send for Circulars. 1522 Monadnock, Chicago.

MACHINERY
For Reducing and Pointing Wire.
ESPECIALLY ADAPTED TO POINTING WIRE RODS AND WIRE FOR DRAWING.
For Machines or Information address the Manufacturer,
S. W. GOODYEAR, Waterbury, Conn.

WM. O. WEBBER.

Gold dollars for fifty cents each

UNTIL SEPT'R FIRST.

THE CONTENTS FOR AUGUST ARE:

Workshop Economics—The Milling Machine,	Chas. O. Heggem.
Heating with Exhaust Steam,	W. H. Wakeman.
Among the Shops,	Fred H. Colvin.
Counterbalancing,	W. H. Booth.
Notes from Notown,	Ichabod Podunk.
A Turret Tool,	Wm. O. Webber.
More About Boring Cylinders.	J. B. Thomas.
Slide-valve Study,	Robert Grimshaw.
An Electric Travelling Crane,	A. Bollinckx.
About Drilling Holes,	Herman Ritter.
Help Wanted,	Thomas Pray.
Three Kinds of Jigs.	What Mechanics Think.

MACHINERY is now established on a permanent and substantial basis, with readers in nearly every civilized country and a regular issue of 15,250 copies. We are encouraged by this result to believe that the mechanical public will support us in further efforts to publish a good, practical paper at a low price; and beginning with the September issue the number of reading pages will be doubled, the outlay will be more than doubled, many new and valuable features will be added, and the price raised to one dollar a year; but present subscribers and those who subscribe before that date, will, of course, receive their paper till the termination of their subscriptions.

No subscriptions at fifty cents each will be received after August 31st, next.

If you want a dollar for fifty cents, now is the time to get it.

SAMPLE COPIES, FREE.
SINGLE SUBSCRIPTIONS, 50 CENTS A YEAR.
FOREIGN SUBSCRIPTIONS, 75 CENTS A YEAR.
Until September first, only.

Address— **Machinery,**
Pearl and Rose Sts., N. Y. City.

Our advertisement appears in the first issue of each month.

BUILDERS IRON FOUNDRY,
FOUNDERS AND MACHINISTS,
PROVIDENCE, R. I.
We can guarantee that our castings will be uniform and of high tensile strength. Tensile strength of ten specimens taken from an air furnace heat:

34,260 lbs.	34,390 lbs.	32,600 lbs.	33,200 lbs.	34,400 lbs.
36,420 "	34,650 "	32,460 "	36,550 "	36,700 "

Dixon's Silica Graphite Paint
Will preserve a roof for TEN to FIFTEEN YEARS—perhaps longer, without repainting.
Unequaled for SMOKE STACKS, BOILER FRONTS, Etc.
Send for circulars on Paints and Painting.
JOS. DIXON CRUCIBLE CO., Jersey City, N. J.

COILS and BENDS of IRON, BRASS, and COPPER PIPE of every description.
The National Pipe Bending Co.
82 River St., New Haven, Conn.

EVERY MACHINIST SHOULD HAVE A COPY OF
OUR CATALOGUE.
It is a 704 page cloth bound book. A copy will be sent, express paid, to any one sending $1.00, and the money paid for book will be refunded with first order amounting to $10.00 or over
MONTGOMERY & CO.,
105 FULTON STREET, NEW YORK CITY.

BOSTON GEAR WORKS
FRANK BURGESS, Proprietor, 35 Hartford St., Boston, Mass.
Any size or style. Spur, Bevel, Spiral, Ratchet, Worm, Rack, Elliptic, Internal, etc. Small or large.
Send for Catalogue. 1,100 sizes of Gears.

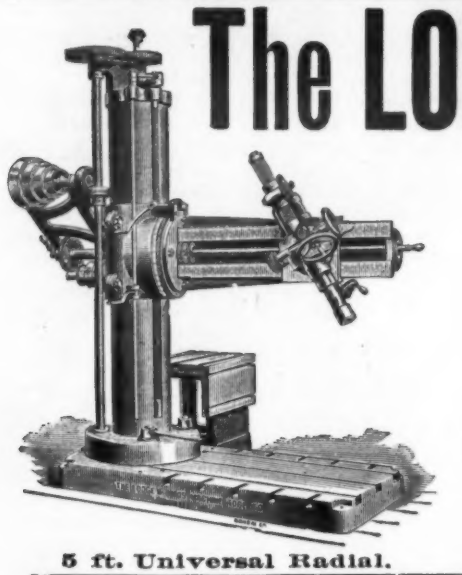
FOR SALE.
PUNCHES and SHEARS.
Also a number of Punch and Shearing Machines, Small Rolls, etc. Write for prices. Address
WAIS & ROOS PUNCH AND SHEAR CO.,
CINCINNATI, OHIO.

Punch for Webb of Rail.

HYDRAULIC MACHINERY,
PRESSES, PUMPS, PUNCHES,
JACKS, VALVES, FITTINGS, PACKINGS,
ACCUMULATORS,
SEND FOR CATALOGUE D.
The W. & S. Hydraulic Machinery Works,
WATSON & STILLMAN, Proprietors,
204, 206, 208 and 210 East 43d St.,
NEW YORK.

Forging Press.

The LODGE & DAVIS MACHINE TOOL CO.



5 ft. Universal Radial.

DESIGNERS AND BUILDERS OF

Plain and Universal Radial Drills, Upright Drills, Planers, Engine Lathes, Milling Machines, Screw Machines, Bolt Cutters, Shapers, Monitor Lathes, Pulley Lathes, Universal Cutter and Reamer Grinders, etc., etc.

Works: CINCINNATI, OHIO, U. S. A.

NEW YORK STORE, 110 Liberty Street.
CHICAGO STORE, 68-70 S. Canal Street.
BOSTON STORE, 36 Federal Street.
PHILADELPHIA STORE, 19 N. Seventh Street.
ST. LOUIS STORE, 720 N. Second Street.
COVENTRY, ENGLAND. Alfred Herbert, Agent.

Lathes

OUR PAT. RADIAL DRILLS ARE BEST.

Good tools produce good work, we use only the finest machinery and employ the most skilled Mechanics, hence, are in position to offer the best Mechanisms to be obtained at a moderate price.

ENGINE LATHES.

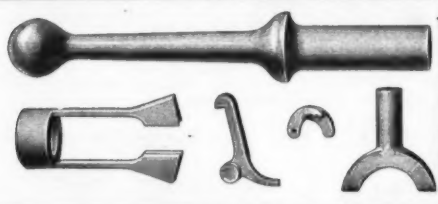
22" and 24" furnished in lengths of 8, 10, 12, 14, and 16 feet Bed. With all modern Improvements.

Address, Dietz, Schumacher & Co., Cincinnati, O., U. S. A.

CHUCKING LATHES

THE LODGE & SHIPLEY M. T. CO.,

CINCINNATI, O., U. S. A.



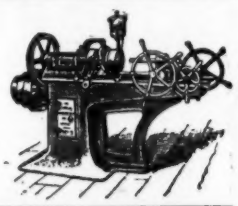
WYMAN & GORDON DROP FORGINGS

WORCESTER, MASS.

BOLT and NUT MACHINERY.

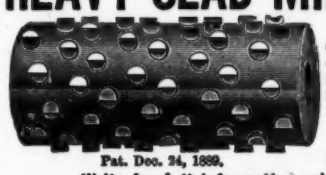
WRITE FOR CATALOGUE AND PRICES.

Bolt Cutters, Pointers, Headers, Nut Tappers, Nut Machines, Upsetting and Bending Machinery, Washer Machines, Wire Nail Machinery, Hand and Automatic Spike Machines, Car Link and Pin Machinery.



The NATIONAL MACHINERY CO. TIFFIN, OHIO.

HEAVY SLAB MILLING MACHINES.



Pat. Dec. 24, 1889.

REGULAR SIZES.

60	inch by	60	inch by	12	feet.
48	" "	48	" "	12	"
36	" "	36	" "	8	"
24	" "	24	" "	6	"
15	" "	15	" "	4	"

PATENT CUTTERS. SPECIAL MILLING MACHINES DESIGNED.

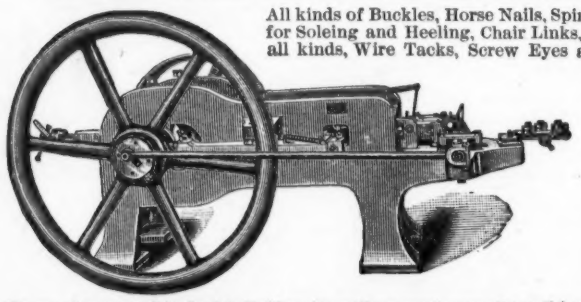
Write for full information, photographs and prices.

THE INGERSOLL MILLING MACHINE CO., ROCKFORD, ILLINOIS, U. S. A.

MEYER, ROTH & PASTOR,

Machinists, Cologne o/Rhine.

Manufacture Machines for the making of the following articles, such as



All kinds of Buckles, Horse Nails, Spiral Springs, Tin-opening Keys, Nails for Soleing and Heeling, Chair Links, Box and Coffin Handles, Rivets of all kinds, Wire Tacks, Screw Eyes and Screw Hooks, Cramps, Hinges, Lock and Piano Nails, Hob Nails of all kinds, Corset Buttons, Sliding Bolts, Eyes, Loops, Leaden Rivets, Leads, Spring Bands, Square Nails for Heeling; Wire Bending and Wire Cutting Machines, Shaping Machines, Machines for making Hooks and Eyes for Ladies' Dresses, Trowsers Hooks and Trowsers Eyes, as well as Hooks and Eyes for Military Cloaks; Tacks and Rivet Presses, etc.

We are also prepared to furnish Machines for making a great many other articles not mentioned above, on receipt of Samples.

THE STIRLING

WATER TUBE SAFETY BOILERS.

SAFE. ECONOMICAL. DURABLE.

No cast metal. No flat surfaces. No multitudinous hand-hole plates and gaskets to remove, clean and make tight with every cleaning. Four manholes give access to interior of every tube. Write for catalog Z.

THE STIRLING CO., Gen'l Offices, CHICAGO, ILL.

Branches in all Cities. PULLMAN BLDG.

GISHOLT TURRET LATHES

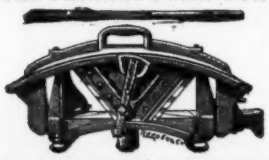
AND

UNIVERSAL TOOL GRINDERS.

SEND FOR PARTICULARS.

MADISON, WISCONSIN.

THE PERKINS DRAW STROKE TRIMMER,



An Indispensable Tool for all Bench Woodworkers. Latest and Best Design. Infringers Prosecuted. Trial, not orders, solicited.

PERKINS & CO., Grand Rapids, Mich.
STOCKS, NEAVE & CO., Manchester, England.

PRATT INSTITUTE, BROOKLYN, N. Y.

Drawing and Machine Design, Two-Years Course.
Machine Work, Two-Years Course.
Evening Course in Machine Work for Beginners at the Trade.

Other Evening Courses in Mechanical Drawing, Algebra, Geometry, Physics, Electrical Construction, Steam, Strength of Materials and Mechanism. Fall Term begins September 23d.
For application blanks and further information, address, F. B. PRATT, Secretary

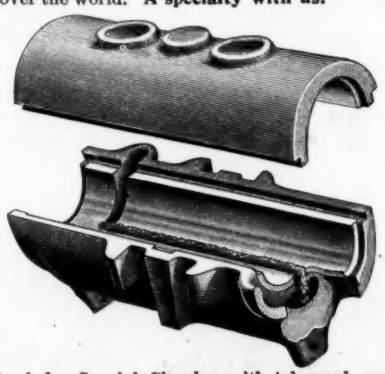
MILLING CUTTERS IN VARIETY

MANUFACTURED BY J. ERLANDSEN, 172 CENTRE ST. NEW YORK. SEND FOR CATALOGUE

WARRANTED

O SAY DID YOU SEE

Pryibil's Elegant Hanger Boxes? They are reamed on a special machine which leaves the bearing surface very smooth and **polished.** The bore being very exact, the shaft has the maximum amount of bearing. The oil chamber is of generous proportions and the method of lubrication simple, positive and reliable. Hangers of neat design, correct proportions and very best workmanship. **HANGERS OF ALL KINDS.** We are sending them all over the world. **A specialty with us.**



Send for Special Circular with telegraph code. We make immediate shipments. Our catalogue "C" is devoted wholly to Pulleys, Hangers, Shafting, etc. Sent free to any address. Try a sample **Hanger** by express.

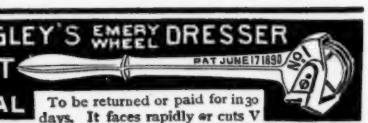
P. PRYIBIL, 512-524 W. 41st ST., NEW YORK.
Cable "Pryibil, New York." Use A B C Code.

J. T. SLOCOMB & CO., PROVIDENCE, R. I. U. S. A.

COMBINED DRILL AND COUNTERSINK FOR CENTERING LATHE WORK.

WRIGLEY'S EMERY WHEEL DRESSER

SENT ON TRIAL



To be returned or paid for in 30 days. It faces rapidly or cuts V grooves and all Shapes. **Cutters Never Get Dull---Are Self-Hardening.** Has Hardened Steel Bushings at Pin Bearings. Price, $2.00; Cutters, 15 cts. per set. Send for Circular.

T. WRIGLEY, 85-87 Fifth Av., Chicago, Ill., U. S. A.

WOOD WORKING MACHINERY

of every description.

Illustrative and descriptive matter on application.

J. A. FAY & CO., 293-313 W. FRONT ST., CINCINNATI, OHIO.

GRINDING IS THE ONLY CORRECT WAY

of finishing work from a profit as well as quality standpoint; then why not use this method? In doing so don't fail to procure a machine that has all the adaptations for doing good work rapidly, for which the essential requirements are: **Free use of water** to keep work cool, wheel clean and avoid dust. Also quick changes of speed of work and traverse of emery wheel to any point between extremes. Our machines embody all of these and many other advantageous features.

For fuller particulars address the manufacturers,

LANDIS BROS., - Waynesboro, Pa.

Germany: Schuchardt & Schutte, 59 Spandauerstrasse, Berlin.
France: Ad. Janssens, 15 Place de la Republique, Paris.

MORSE TWIST DRILL AND MACHINE COMPANY,
Manufacturers of Morse Patent Straight-Lip Increase Twist Drills. New Bedford, MASS.

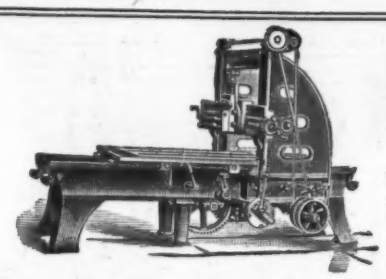
Solid and Shell Reamers, Beach's Patent Self-Centering Chuck, Bit Stock Drills.
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.

F. E. REED CO.,
Worcester, Mass.,
MANUFACTURE
ENGINE LATHES
HAND LATHES, FOOT LATHES AND MILLING MACHINES.
Manning, Maxwell & Moore,
Selling Agents, 111 Liberty Street, New York.
60 South Canal Street, Chicago.
424 Telephone Building. Pittsburgh, Pa.

P. BLAISDELL & CO.,
Manufacturers of
Machinists' Tools,
WORCESTER, MASS.

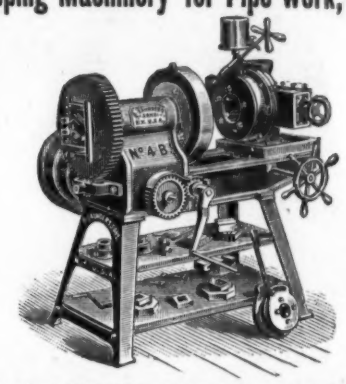
LATHES,
8 to 18 in. Swing.
SEBASTIAN-MAY CO.,
SIDNEY, OHIO.

ALUMINIUM
MODEL ENGINE CASTINGS
DESCRIPTIVE PRICE LIST FREE
CHAS. W. STEVENER,
TARENTUM, PA.



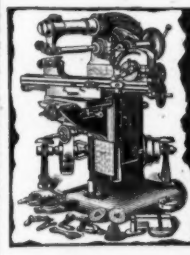
New Haven Manf'g Co.,
NEW HAVEN, CONN.
IRON-WORKING MACHINERY.
CUTTING OFF
MACHINES, the Latest and Best.
HURLBUT ROGERS MACHINE CO.,
SO. SUDBURY, MASS.

D. SAUNDERS' SONS,
MANUFACTURERS OF
PIPE CUTTING AND THREADING MACHINES,
Steam and Gasfitters' Hand Tools,
Tapping Machinery for Pipe Work, etc.

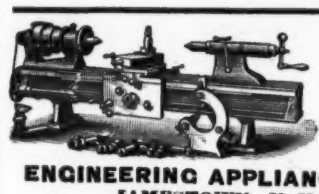


The No. 4 B Machine for Cutting and Threading Pipe ⅛ in. to 4 in., by HAND or POWER.
SEND FOR CATALOGUE TO
21 Atherton St., YONKERS, N. Y.

NEW LINE OF ENCINE LATHES.
DRAPER MACHINE TOOL CO.
SUCCESSOR TO LATHE & MORSE TOOL CO.
WORCESTER, MASS.



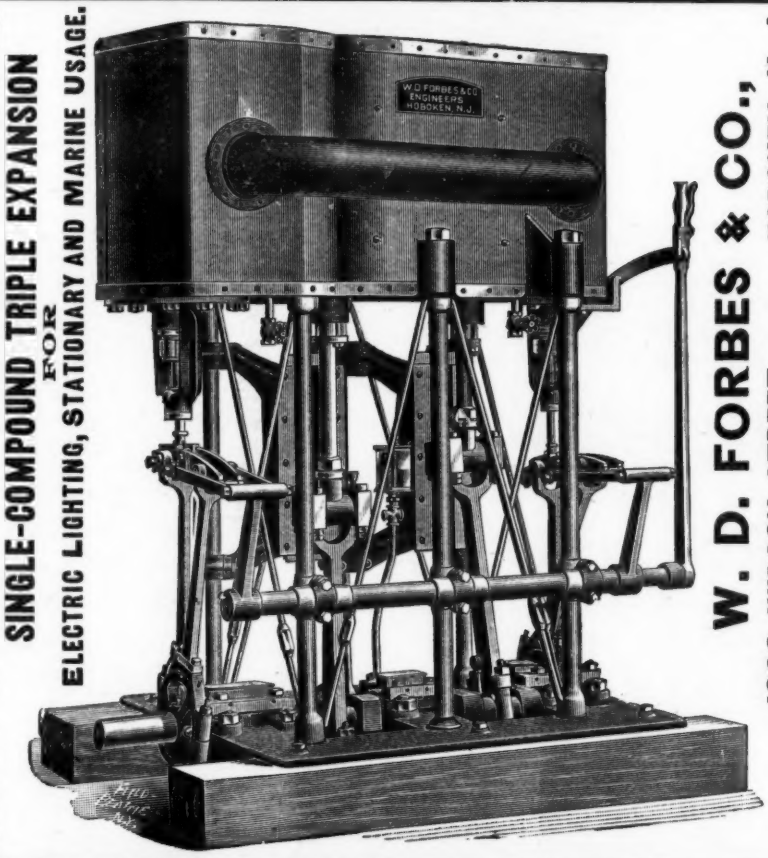
Incorporated 1871.
Brainard Milling Machine Co.
UNIVERSAL PLAIN & SPECIAL MILLING MACHINES. ALSO CAM-CUTTING & MILL-GRINDING MACHINES.
156 OLIVER ST. BOSTON, MASS. WORKS AT HYDE PARK, MASS. U.S.A.
MILLING & GEAR CUTTING MACHINES.
50 Different Sizes & Styles
Cuts & Prices on Application.



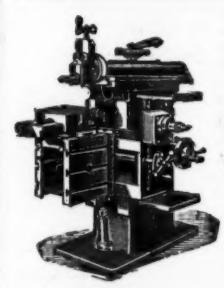
— FOR —
Bicycle
WATCH-WORK
OR
TOOL ROOM.
ENGINEERING APPLIANCE CO.
JAMESTOWN, N. Y.

can be of use to you
TELEPHONES SENT ON TRIAL
UNIVERSAL TELEPHONE CO.
INDIANAPOLIS, IND.

HIGH-SPEED VERTICAL ENGINE.
SINGLE-COMPOUND TRIPLE EXPANSION
FOR
ELECTRIC LIGHTING, STATIONARY AND MARINE USAGE.



W. D. FORBES & CO.,
1302 HUDSON STREET, HOBOKEN, N. J.
TWO BLOCKS FROM 14TH ST. FERRY.



Crank Shaper.
18 in. Crank.
SEND FOR CATALOGUE.
SHAPERS
NEW FEATURES.
FLATHER PLANER COMPANY,
NASHUA, N. H., U. S. A.

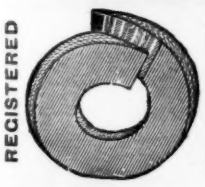
JONES & LAMSON MACHINE CO.,
SPRINGFIELD, VERMONT.

Capacity 2 in. diameter, 24 in. long.
2 BY 24 FLAT TURRET LATHE.

Sole builders of the Flat Turret Lathe, also builders of other Turret Machinery. Publishers of "Rapid Lathe Work," by new method (Hartness System). Send for catalogue.

ARMSTRONG LATHE AND PLANER TOOL.
Used and endorsed by J. A. Fay & Egan Co., Morse Twist Drill and Machine Co., Wiley & Russell Mfg. Co., Fitchburg Machine Works and by all who have given it a trial.
Send for circular and prices.
MFG. ONLY BY
Armstrong Bros. Tool Co.,
76 EDGEWOOD AVE.,
CHICAGO.

REGISTERED TRADE MARK.

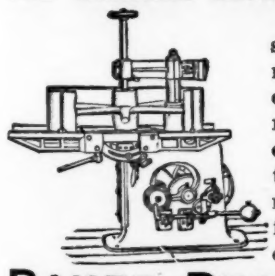


GOULD'S
STEAM AND WATER PACKING.
THE ORIGINAL RING PACKING.
In ordering give EXACT diameter of Stuffing Box and Valve Stem.
None genuine without this Trade Mark.
THE GOULD PACKING CO., - East Cambridge, Mass.

A **Milling Machine** or . . . .
a **Cutter and Tool Grinder.**

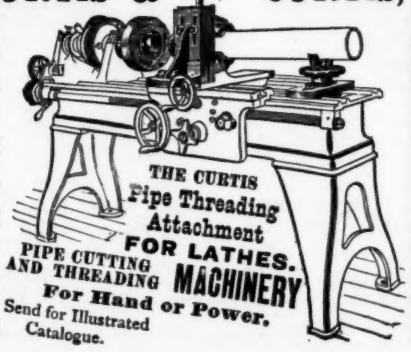
If you need either, and where is the shop that doesn't? write
The Cincinnati Milling Machine Co.,
Cincinnati, Ohio.

THE COLBURN KEYWAY CUTTER.



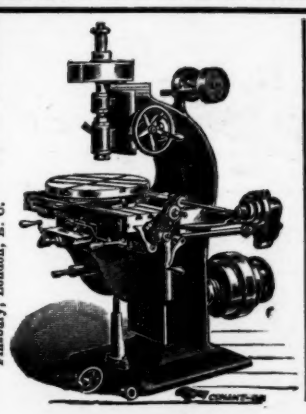
Built in four sizes. Combines many points of excellence. For rapid work and exact duplication of same it has no equal. Send for illustrated catalogue.
BAKER BROTHERS,
365 S. Erie St., TOLEDO, OHIO.

CURTIS & CURTIS,
66 Garden St., Bridgeport, Ct.



THE CURTIS Pipe Threading Attachment FOR LATHES.
PIPE CUTTING AND THREADING MACHINERY For Hand or Power.
Send for Illustrated Catalogue.

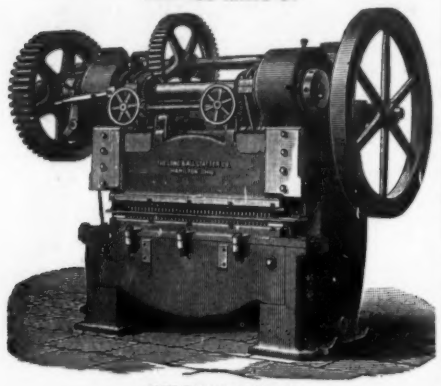
THE BECKER MILLER No. 4
MANUFACTURED BY
JOHN BECKER MANUFACTURING CO.,
FITCHBURG, MASS.
ENGLAND—CHAS. CHURCHILL & CO. Ltd., 21 Cross St., Finsbury, London, E. C.



BARNES'
UPRIGHT DRILLS

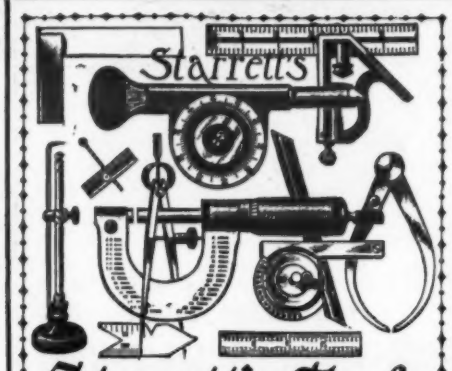
Complete line, ranging from our New Friction Disk Drill, for light work, to 42-inch Back Geared Self Feed Drill.
Send for Catalogue and Prices.
W. F. & JOHN BARNES CO.,
1995 Ruby St., Rockford, Ill.
ENGLISH AGENTS,
CHAS. CHURCHILL & CO., LTD.,
21 CROSS ST., FINSBURY, LONDON, E. C., ENG.

The LONG & ALLSTATTER CO.,
HAMILTON, OHIO,
Multiple Punches and Gate Shears
FOR ALL KINDS OF



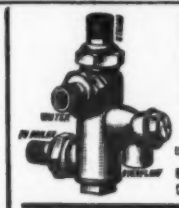
MULTIPLE PUNCH.

BOILER, TANK AND STRUCTURAL IRON WORK, ROLLING MILLS, LOCOMOTIVE SHOPS, CAR AND WAGON WORKS, PLOW SHOPS, &c., &c.

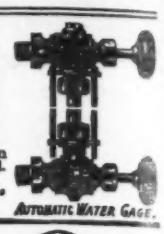


Starrett's Tools
ARE WARRANTED SATISFACTORY.
SEND FOR CATALOGUE.
L. S. STARRETT, ATHOL, MASS., U. S. A.

W. C. YOUNG MFG. CO., WORCESTER, MASS.
Foot Lathes, Engine Lathes,
SHEARS AND PUNCHES.



—THE—
PENBERTHY
SPECIALTIES.
FOR THE BOILER AND ENGINE. ARE THE ENGINEERS' FAVORITES.
$5,000 PENBERTHY AUTOMATIC INJECTORS in use, giving perfect satisfaction under all conditions. Our Jet Pumps, Water Gages and Oil Cups are Unequalled.
SEND FOR CATALOGUE. PENBERTHY INJECTOR CO. DETROIT, MICH.
BRANCH FACTORY AT WINDSOR, ONT.



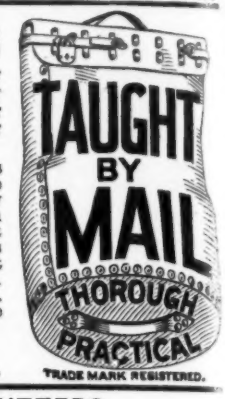
MECHANICAL DRAWING

Mechanics; Electricity; Architecture; Architectural Drawing and Designing; Masonry; Carpentry and Joinery; Ornamental and Structural Iron Work; Steam Engineering (Stationary, Locomotive or Marine); Railroad Engineering; Bridge Engineering; Municipal Engineering; Plumbing and Heating; Mining; Prospecting, and the English Branches.

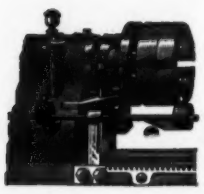
The courses commence with addition in Arithmetic, so that to enroll it is only necessary to know how to read and write. A Scholarship entitles the holder to tuition, until he is qualified to receive the Diploma, no matter how long it may take nor how often it may be necessary to review. Students can interrupt their studies and change their residences. Scholarships are not forfeited upon failure to pay installments promptly. Each student is a class by himself, and has the advantage of individual direction by a competent instructor. Students make rapid progress in learning to Draw and Letter. Specially prepared Instruction and Question Papers, Condensed, Simplified. The Steam Engineering course is intended to qualify engineers to secure Licenses. All representations may be relied upon.

Send for Free Circular, stating the subject you wish to study, to

The International Correspondence Schools, SCRANTON, PA.

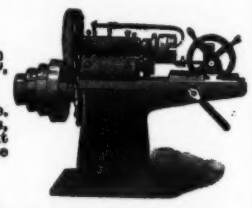


DETRICK & HARVEY MACHINE CO.,
BALTIMORE, MD.
MANUFACTURERS OF THE
ADAMS
Automatic Bolt-Threading and Nut-Tapping Machine,
Made in all Sizes to Cut from 1-4" to 6".



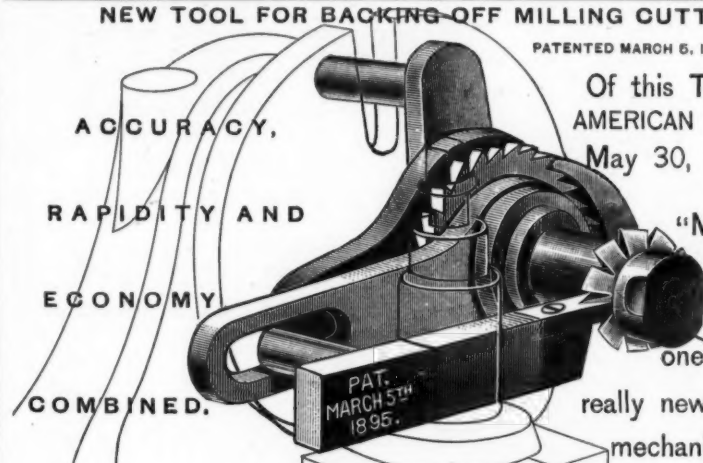
The simplest and most durable machine in existence. The threading head is made entirely of steel. No links, levers, springs, caps, cases, blocks or die rings in or about the head. Separate Heads and Dies Furnished. Write for descriptive circular and price list.

Manufacturers of The Open Side Iron Planer.



NEW TOOL FOR BACKING OFF MILLING CUTTERS.
PATENTED MARCH 5, 1895.

ACCURACY,
RAPIDITY AND
ECONOMY
COMBINED.



Of this Tool the AMERICAN MACHINIST, May 30, 1895, said:

"Mr. Balzer's device we believe to be one of the few really new things in mechanics."

For descriptive circular apply to

S. M. BALZER,
39, 41 CORTLANDT ST., NEW YORK CITY.

C. H. BAUSH & SONS,
HOLYOKE, MASS.
Manufacturers of

Patent Radial Drills
of every description.
All sizes from 3 ft. to 10 ft. arm.

Albro Worm and Worm Gear

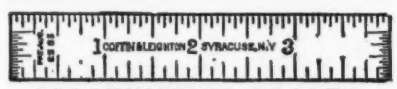
Consumes less power and gives better results than any other System. Information cheerfully furnished.

The Albro-Clem Elevator Co.,
411 & 413 Cherry St.,
Philadelphia, Pa.

BOSS SCREW PITCH GAGE.
A full line of Pitches from 4 to 40.

FOR 'NSIDE AND OUTSIDE WORK.
Mailed till October 1st for $1.00.

STANDARD TOOL CO.,
ATHOL, MASS., U. S. A.
Catalog of latest designs in Machinists' Fine Tools to be had for the asking.

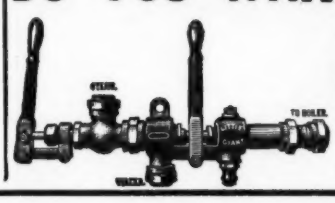


MACHINISTS' SCALES,
PATENT END GRADUATION.
We Invite Comparison for Accuracy with all others.
EVERY SCALE GUARANTEED. SEND FOR LIST.
COFFIN & LEIGHTON, SYRACUSE, N. Y.

ALL GENUINE INGOTS & MANUFACTURES BEAR OUR REG. TRADE MARKS.

PHOSPHOR-BRONZE
INGOTS, CASTINGS, WIRE, SHEET &c.
THE PHOSPHOR BRONZE SMELTING CO. LIMITED
2200 WASHINGTON AVE. PHILADELPHIA, PA.
ORIGINAL MANUFACTURERS OF PHOSPHOR-BRONZE IN THE UNITED STATES AND SOLE MAKERS OF "ELEPHANT BRAND" PHOSPHOR-BRONZE.

DO YOU WANT TO GET ACQUAINTED

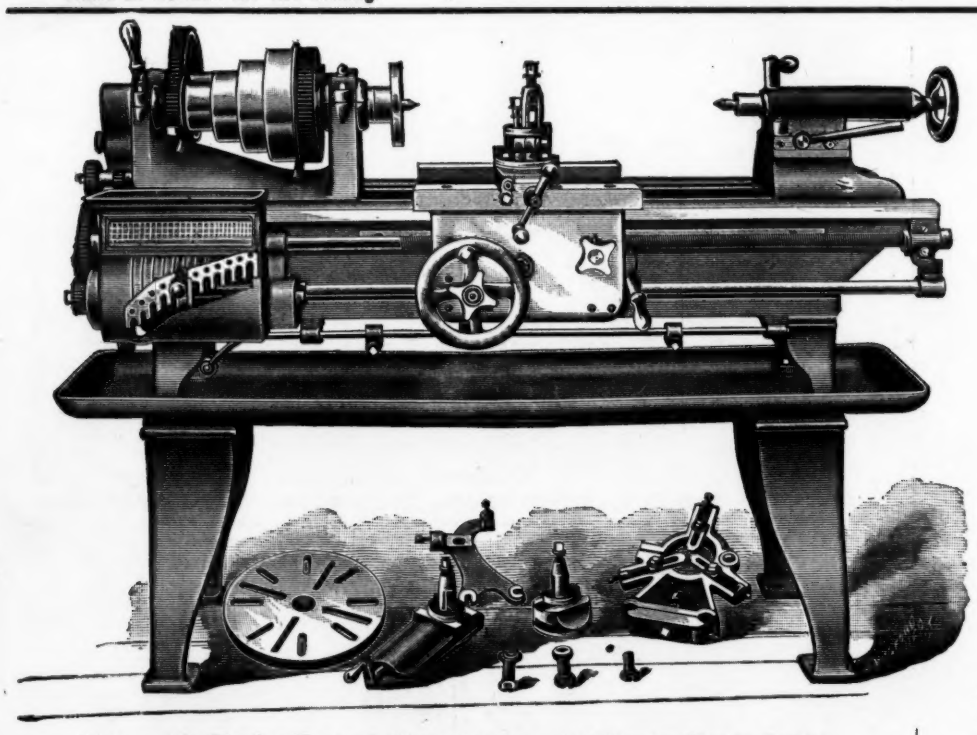


with the best Lifting Locomotive Injector made? If so, send for

Catalogue of RUE'S "LITTLE GIANT."

It contains also much useful information on the subject of Injectors in general, such, as we think, will be of interest to every Engineer or Fireman, as well as to Mechanics and Engineers generally.

RUE MFG. CO., 118 North 9th St., Phila., Pa.

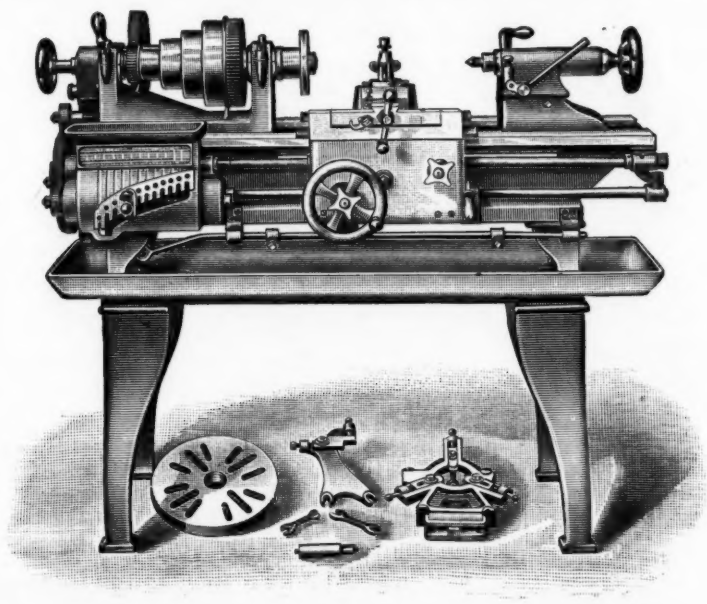


14 in. x 6 ft. Hendey-Norton Lathe and 12 in. x 4 ft. Hendey-Norton Lathe.

These are modern, high grade, practical tools, and are especially adapted for tool-room work.

They have the Norton attachment for screw cutting, giving 36 different threads and 36 different feeds with only two changes of gear, and movement of lever in gear box from one notch to the other.

Note the automatic stop under apron. It will automatically stop carriage at any desired point in either direction. Invaluable for internal or duplicate work.



The 12 in. lathe is fitted with drawing-in sleeve and American Watch Tool Co's. Standard Chuck, used in making small taps, reamers, etc.

Work finished first and cut from bar afterward. No centering required.

See carriage reverse lever by right-hand side of apron; no reaching for counter-shaft shipper required. Send for catalogue.

THE HENDEY MACHINE CO., Torrington, Conn.

EUROPEAN AGENTS: CHAS. CHURCHILL & CO., LONDON, ENG.
SCHUCHARDT & SCHUTTE, BERLIN, GERMANY.
EUGEN SOLLER, BASEL, SWITZERLAND.

OUR WET EMERY GRINDER

—was designed and built to enter a market where tools of its class were by no means unknown. In winning the hearty indorsement of some of the most exacting mechanics in this country it has been pre-eminently successful. It effectually solves the vexed problem of Water-supply, and illustrates in its construction simplicity and high efficiency happily wedded. Its many vital points of excellence are clearly set forth in a circular, which it would afford us pleasure to mail you.

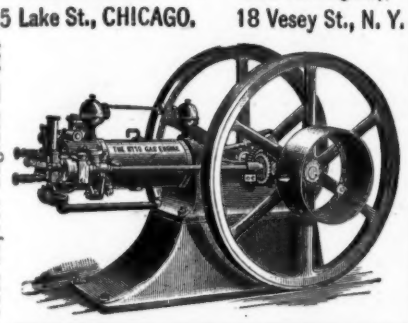
LELAND & FAULCONER M'F'G CO.,
Detroit, Michigan.

"THE OTTO" GAS ENGINE WORKS,

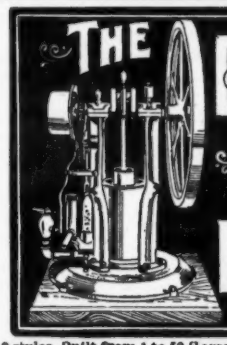
33d and Walnut Sts., PHILADELPHIA.

Branch Office, 245 Lake St., CHICAGO.
New York Agency, 18 Vesey St., N. Y.

Over 40,000 Engines in Use



THE BACKUS GAS ENGINE

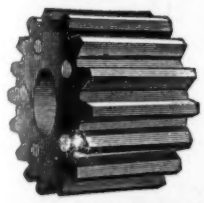


2 styles, Built from 1 to 50 Horse Power. Send for Circular.
BACKUS WATER MOTOR CO., Newark, N. J.
Also Mfrs. VENTILATING FANS.

STRANGE, BUT TRUE!!

THE NEW PROCESS RAW HIDE GEARS

ASTONISH THE MACHINERY WORLD.



They **Outwear** any Metal.

They require **No Lubricant.**

They are **Noiseless and Clean.**

NEW PROCESS RAW HIDE CO.,
PATENTEES AND SOLE MANUFACTURERS,
SYRACUSE, N. Y., U. S. A.

KEUFFEL & ESSER CO.

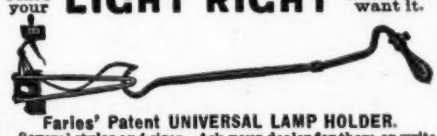
NEW YORK.
Branches: 111 Madison St., Chicago.
708 Locust St., St. Louis.

DRAWING MATERIALS AND Surveying Instruments.

The largest and best assorted stock in America. All requisites for field and draughting room. We have made a study of this line, and our goods are warranted to be as nearly perfect as it is possible to make them. Prices reasonable.

CATALOGUE ON APPLICATION.

Place your **LIGHT RIGHT** where you want it.



Faries' Patent UNIVERSAL LAMP HOLDER.
Several styles and sizes. Ask your dealer for them or write direct to FARIES MANUF'G CO., Decatur, Ill.
Catalogue free.

SWEET'S Measuring Machine.
The only micrometer that will not lose its accuracy by wear.
Satisfaction Guaranteed,
SYRACUSE TWIST DRILL CO.,
Syracuse, N. Y.

TELESCOPES

SEND FOR CATALOGUE
W. & D. MOGEY,
45TH ST. BAYONNE N.J.

LATEST! BEST! CHEAPEST!

COLD METAL SAWING MACHINES.

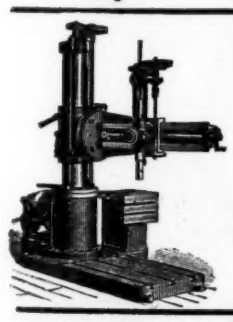
THE Q AND C

FOR ALL CLASSES OF WORK.

EVERY MACHINE WARRANTED.

SEND FOR NEW CATALOGUE.

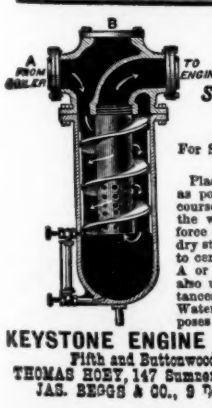
CHICAGO, ILL., - - 703-7 WESTERN UNION BLDG.
NEW YORK, - - - - 29 BROADWAY.



OUR LATEST PRODUCTION.

No. o Radial Drill. Something entirely new. Advantages for all shops. Now ready for you.

BICKFORD DRILL AND TOOL CO.,
3 Pike Street, Cincinnati, Ohio.



DRY STEAM.

Simpson's Centrifugal Steam Separator.

For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.

Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.

KEYSTONE ENGINE & MACHINE WORKS,
Fifth and Buttonwood Streets, Philadelphia.
THOMAS HOEY, 147 Sumner St., E. Boston, Mass., Agent.
JAS. BEGGS & CO., 9 Dey St., New York, Agents.

MOFFET PORTABLE DRILL.

UNSURPASSED AS A **REAMER.**

Will work in any position.

Weighs 48 lbs. and drills from ⅛ to 2¼ inches diameter.

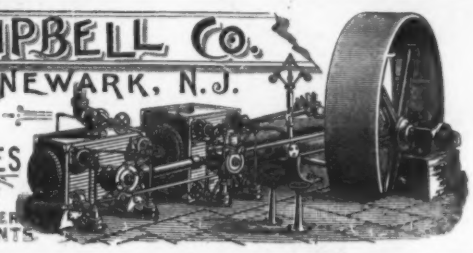
Runs with Steam —OR— Compressed Air.

Send for Circular.

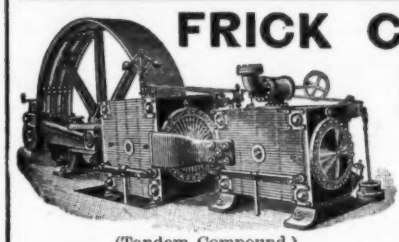
Manufactured by
J. G. TIMOLAT,
465 & 467 W. Broadway,
NEW YORK.

THE WATTS, CAMPBELL CO.

MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.
NEWARK, N.J.
CONTRACTS TAKEN FOR COMPLETE POWER PLANTS



FRICK COMPANY, WAYNESBORO, PA.



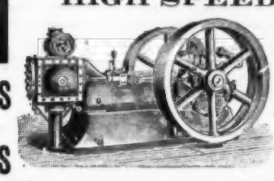
(Tandem Compound.)

ECLIPSE CORLISS ENGINES,

40 TO 2,000 H. P., ALL STYLES.
Send for Illustrated Catalogue.
ALSO BUILDERS OF
Electric High Speed Engines and Ice-Making and Refrigerating Machinery.

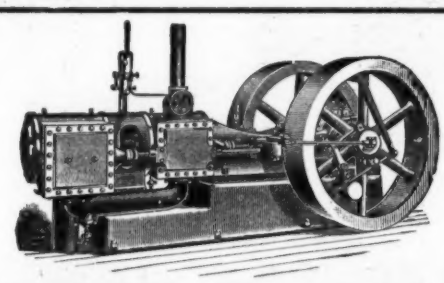
WESTON AUTOMATIC HIGH SPEED ENGINES

HIGH PRESSURE BOILERS AND COMPLETE POWER PLANTS



WESTON ENGINE CO., Painted Post, N. Y.

REPRESENTATIVES.
Julian Scholl & Co., 126 Liberty St., N. Y. City.
Scranton Supply & Machinery Co., Scranton, Pa.
Hoffman-Russell Co., 82 Lake St., Chicago, Ill.
Thos. K. Carey & Bros. Co., 26 Light St., Baltimore, Md.

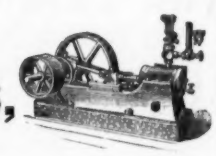


AMES IRON WORKS, OSWEGO, N. Y.

38 Cortlandt St., New York City.
18 South Canal St., Chicago, Ill.
50 Oliver St., Boston, Mass.
1026 Filbert St., Philadelphia, Pa.

ORR & SEMBOWER,

(INCORPORATED.)
VERTICAL, HORIZONTAL, MARINE —AND— HOISTING ENGINES,
VERTICAL AND HORIZONTAL BOILERS.
READING, PA.
WESTERN BRANCH, 60 S. CANAL STREET, CHICAGO.



"EXCELSIOR" VALVES.

THE BEST.

Specially Designed for High Steam Pressure.

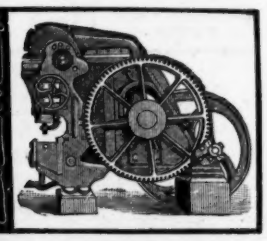
ADVANTAGES:
Can be Re-packed Under Any Pressure.
Has Self-Locking Packing Nut. Can be Re-ground in Place.

THE KELLY & JONES CO.,
104 JOHN STREET, NEW YORK.

Write for Descriptive Circular.

PUNCHING AND SHEARING MACHINERY AND BOILER MAKERS ROLLS.

NEW DOTY MANUFACTURING CO.
JANESVILLE WISCONSIN.



A. & F. BROWN,

ENGINEERS, FOUNDERS & MACHINISTS.

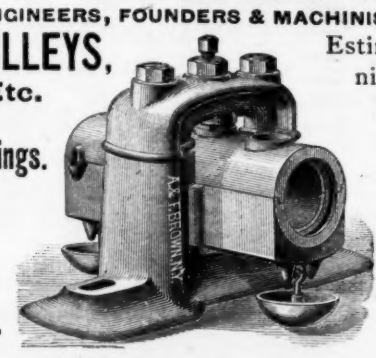
SHAFTING, PULLEYS, HANGERS, Etc.

Friction Clutch Couplings.

STEAM SIRENS.
[WHISTLES.]

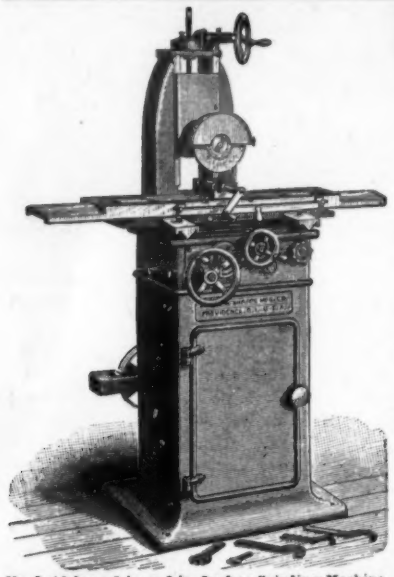
Send for Catalogue.

17 Dey St., New York.



Estimates and Plans furnished for transmitting Power by HORIZONTAL AND VERTICAL SHAFTING.

Also for Erecting same.



No. 2, 18 in. x 6 in. x 5 in. Surface Grinding Machine.

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I.

This machine grinds work to 18 in. long, 6 in. wide and 5 in. high.

Catalogue describing this and other machines sent on application.

England—BUCK & HICKMAN 280 Whitechapel Road, London, E.
England—CHAS. CHURCHILL & CO., Ltd., 21 Cross St., Finsbury, London, E. C.
Germany—SCHUCHARDT & SCHUTTE, 59 Spandauerstrasse, Berlin, C. (Small Tools).
Germany—GUSTAV DIECHMANN & SOHN, Zimmer-Strasse 87, Berlin, S. W. 12, Germany.
France—FENWICK FRERES & CO., 21 Rue Martel, Paris.
France—F. G. KREUTZBERGER, 140 Rue de Neuilly Puteaux (Seine.)
Chicago, Ill.—FRED. A. RICH, 23 So. Canal St.
New York City—F. G. KRETSCHMER, 136 Liberty St. Room 503.

MACHINE TOOLS.

63-INCH FORGE LATHE.

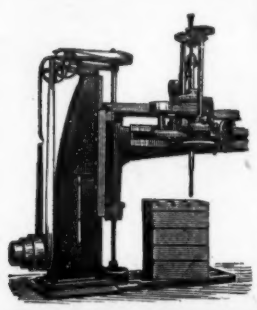
THE NILES TOOL WORKS CO.,

HAMILTON, OHIO. Correspondence Solicited.

THE ORIGINAL UNVULCANIZED PACKING.

Jenkins Standard Packing has been severely tested in all positions and under all actions of steam, superheated steam, oils, acids, etc., and has never failed to make a perfect joint when properly applied. See that it is stamped "Jenkins Standard Packing" and bears Trade Mark.

JENKINS BROS., New York, Boston, Philadelphia, Chicago.



WM. SELLERS & CO., Incorporated,

PHILADELPHIA, PA.

MANUFACTURERS OF

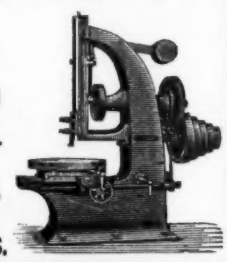
MACHINE TOOLS,

TRAVELING CRANES AND SWING CRANES,

Operated by Electricity, Shafts or Independent Engines.

Turn Tables, Testing Machines, Shafting, Pulleys, Hangings, Couplings, etc.

INJECTORS FOR ALL CLASSES OF BOILERS.

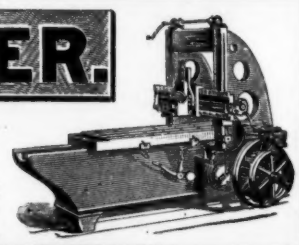


THE GRAY PLANER.

Manufactured by

THE G. A. GRAY CO.,

CINCINNATI, OHIO.



THE FOLLOWING MACHINERY MERCHANTS CARRY SAMPLES.

J. A. Fay & Egan Co.....24 South Canal Street, Chicago.
Strong, Carlisle & Turney Co....193 Bank Street, Cleveland.
E. A. Kinsey & Co.....227 West 4th Street, Cincinnati.
Thos. E. Carey & Bros. Co.....26 Light Street, Baltimore.
J. J. McCabe.....14 Dey Street, New York City.

No. 1 AUTOMATIC TAPPING MACHINE.

For Taps up to 5-16 inch.

IF YOU USE A

TAPPING MACHINE,

WRITE US FOR

PHOTO, DESCRIPTION AND PRICE OF THIS ONE

and the several other kinds and sizes which we build.

WE ALSO MANUFACTURE

Milling Machines, Screw Machines, Cutter Grinders,

Tapping Machines, Drill Presses, Hand Lathes, etc.

Special Bicycle Machinery.

WRITE FOR CATALOGUE AND PRICES.

THE GARVIN MACHINE CO.

Laight and Canal Sts., New York.

Also 51 North 7th St., Philadelphia, Pa.

PRATT & WHITNEY CO.,

HARTFORD, CONN., U. S. A.

Solicit orders for the following machines and appliances for the manufacture of bicycles:

Turret head machines and patented tools for forming hubs from the bar or forgings. Adjustable multi-spindle machines for drilling spoke holes in hubs and rims. Wheel constructing and adjusting tables, sprocket wheel boring and facing machines, tube cutting machines, fork head threading machines, nipple tapping machines, Tucker's open dies, revolving chucks.

New York, 138 Liberty Street. Boston, 47 Pearl Street.
Chicago, 42 and 44 S. Clinton Street.

COMBINATION PLIERS.

Gas Pliers, Wire Cutters, Wrench and Screw Driver Combined.

Drop Forged from Best Tool Steel and Finely Finished.

THE BILLINGS & SPENCER CO.,

HARTFORD, CONN.

Chicago Office, 17 S. CANAL STREET.

England—CHARLES CHURCHILL & CO., 23 Cross St., Finsbury, London, E. C.
France—L. ROFFO, 58 Boulevarde Richard Lenoir, Paris. *Russia—J. BLOCK, Moscow.*

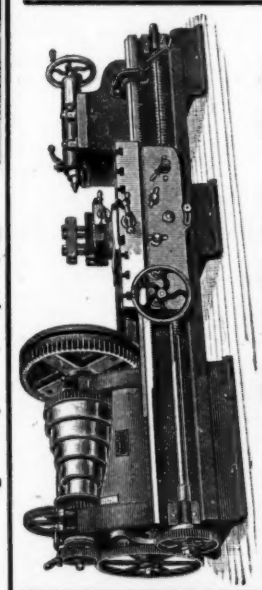
WARNER & SWASEY,

CLEVELAND, OHIO.

IRON & BRASS-WORKING MACHINE TOOLS

Monitor Lathes, Turret Engine Lathes, Screw Machines, Forming Monitors, Boring Mills.

SEND FOR CATALOGUE AND PRICES.



FIFIELD TOOL CO.,

MANUFACTURERS OF

ENGINE LATHES

from 17 to 64 in. swing. Cuts, Photographs and Prices furnished on application.

LOWELL, MASS., U. S. A.

THE HAYDEN & DERBY MFG. CO.,

SOLE MANUFACTURERS

METROPOLITAN INJECTORS,

AUTOMATIC AND DOUBLE TUBE.

Send for our New Book. Sent free.

"Practical Information on Injectors."

OFFICE AND SALESROOMS:

No. 114 LIBERTY ST., NEW YORK.

UPRIGHT DRILLS,

CUTTING-OFF MACHINES,

KEY-SEATING MACHINES

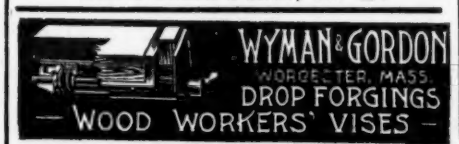
AND

SPECIAL MACHINERY.

Write for Catalogue and Prices.

THE W. P. DAVIS MACHINE CO.,

ROCHESTER, N. Y.



HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
HARTFORD, CONN.

J. M. ALLEN, President.
WM. B. FRANKLIN, Vice-President.
F. B. ALLEN, Second Vice-President.
J. B. Pierce, Secretary & Treasurer.

THE ACME MACHINERY CO.,

CLEVELAND, OHIO.

Manufacturers of

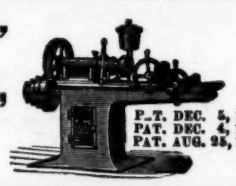
ACME BOLT & RIVET HEADERS,

Acme Single and Double Automatic

BOLT CUTTERS.

Cutting from 1-8 in. to 6 in. diameter.

Also SEPARATE HEADS and DIES.



We make the following sizes of

HENDEY-NORTON LATHES,

12", 14", 16", 18", 20", 24", 27" and 30" swing. Also

IMPROVED HENDEY PILLAR SHAPERS,

15", 24" and 25" stroke.

See our advertisement on page 618 of this paper.

THE HENDEY MACHINE CO., Torrington, - Conn.

Manufacturer —of— TAPS & DIES